Cement MILL SECTION of

Concrete

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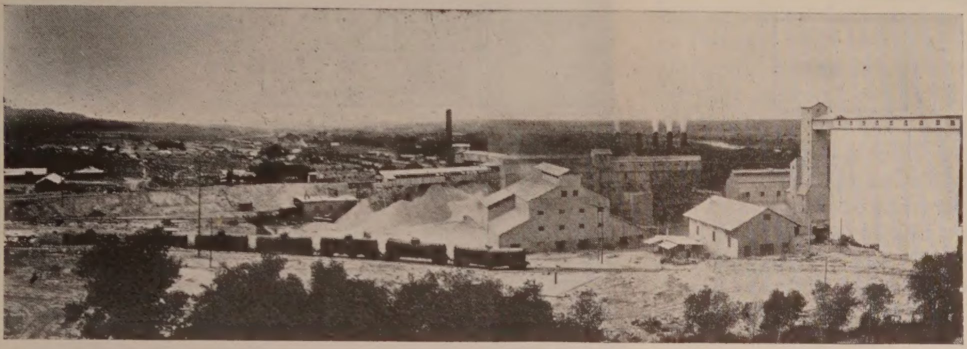

FIG. 1—GENERAL VIEW OF THE GOLDEN STATE CEMENT PLANT, ORO GRANDE, CALIF., SHOWING RAW GRINDING DEPARTMENT AND STONE STORAGE IN THE CENTER FOREGROUND

Increasing a Cement Plant 250%

BY C. L. CARMEN
RIVERSIDE PORTLAND CEMENT CO.

Increasing the capacity of a cement plant along lines laid down by the original plans of the plant, or from plans fully prepared in advance, requires good management to prevent the construction from unnecessarily interfering with the operation of the old unit.

As an illustration of such work successfully accomplished, it may be mentioned that when the original plant of Riverside was doubled in capacity, there was no interference with the operation of the plant, except for three hours shut down of the kiln room to couple up the clinker conveyor and blower pipe extensions.

The successful operation of any plant depends fundamentally upon the perfection of its details, and perfection of detail is not attained except by the expenditure of considerable time, thought and effort, even by the most experienced and competent designers.

When the preparation of the plans must proceed simultaneously with the construction work, and particularly when such work must be done with the time factor as the most important consideration, the responsibility imposed upon the engineering department, and upon those in charge of the construction, is immeasurably greater, and not the least of it all is the task of getting the orders out and the materials in, to prevent delay, as the sequence of their arrival is most important.

The restrictions imposed upon the designer by the type and form of the original plant to which additions are to be made, and particularly when such additions are to be much larger than the original unit, change his problem from that of planning the most modern up-to-date arrangement, to one of developing the most practical one, all things considered, and, after all, is this not the highest type of engineering and good management, or is it just common sense?

It was under such conditions that an increase of

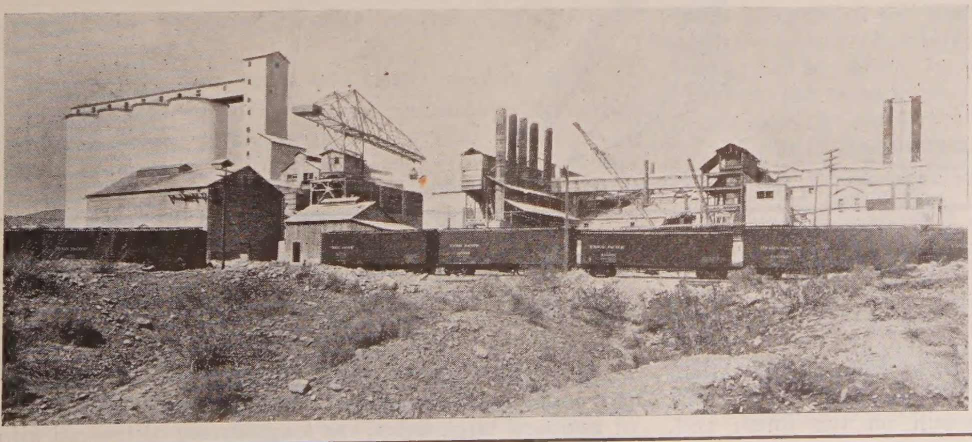

FIG. 2—GOLDEN STATE PLANT COMPLETED AND IN OPERATION. THE FIVE STACKS IN THE CENTER ARE THE FIVE KILN STACKS

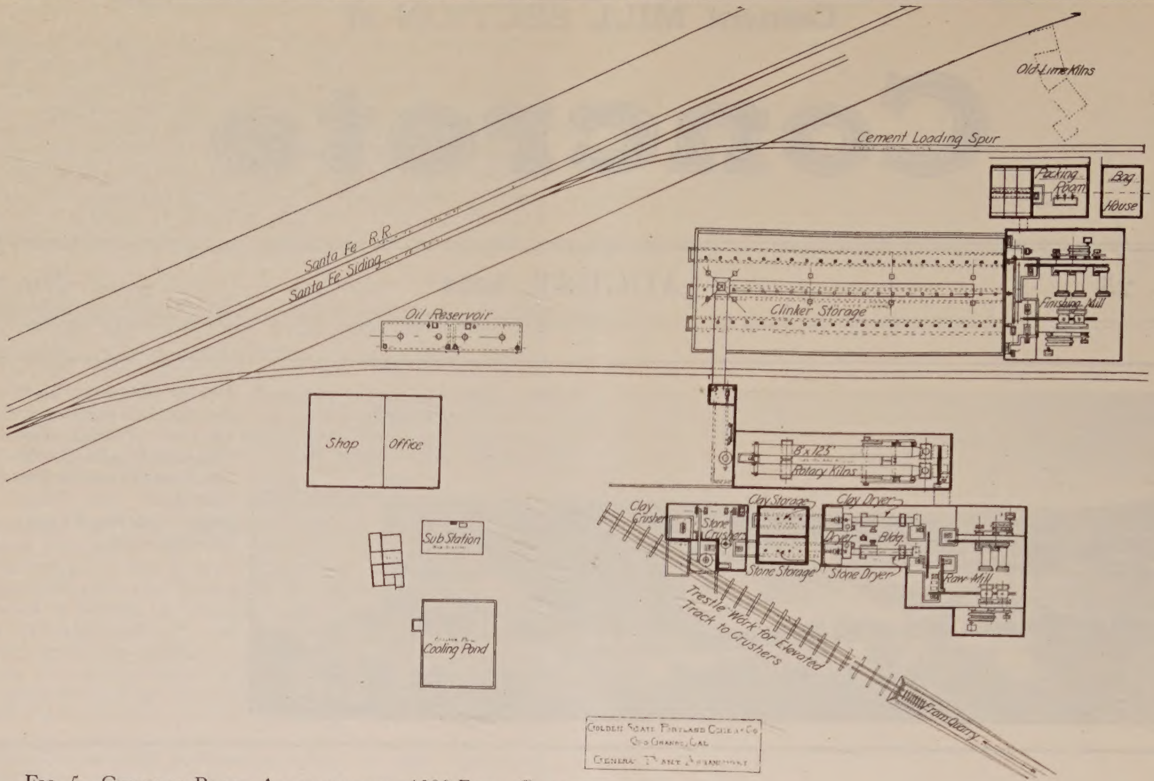

Fig. 5—General Plant Arrangement, 1200 Bbls. Capacity

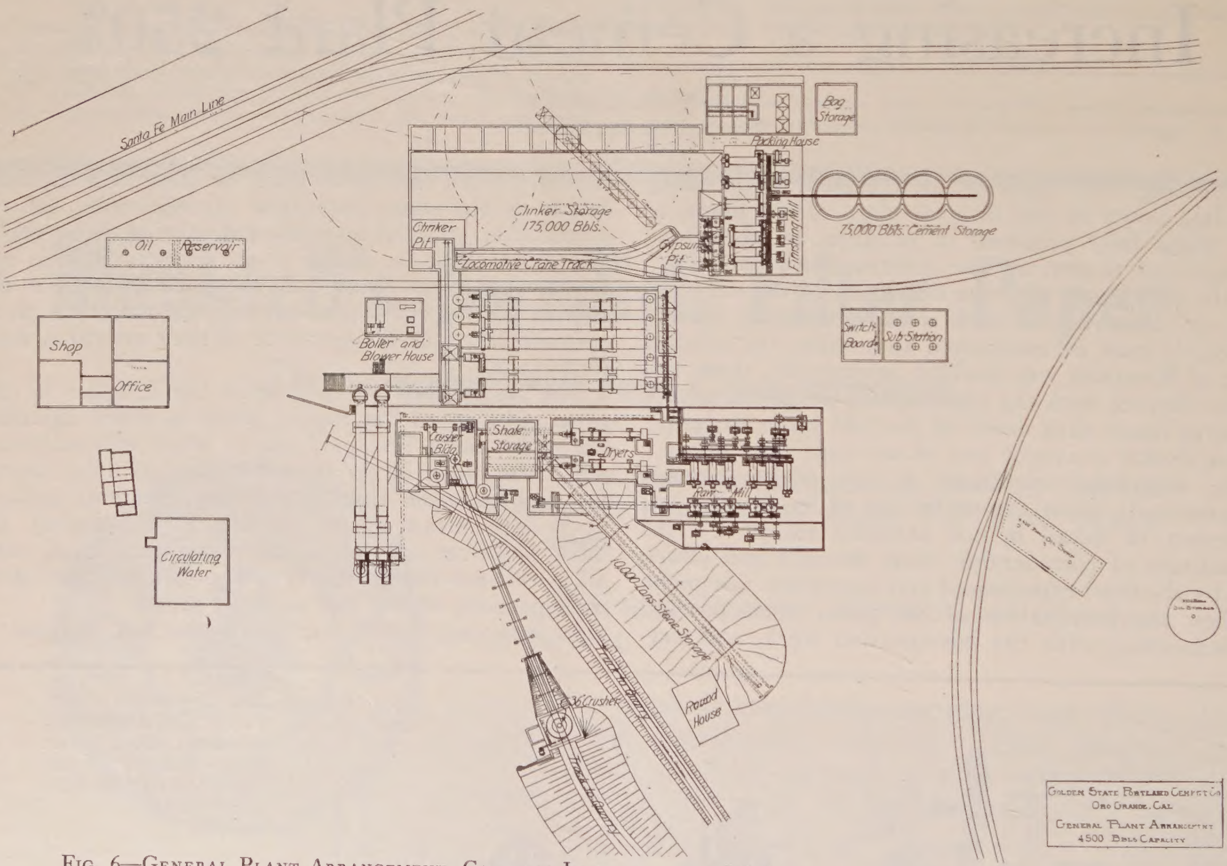

Fig. 6—General Plant Arrangement, Capacity Increased to 4,500 Bbls.

250% in capacity was made to the plant of the Golden State Portland Cement Co., at Oro Grande, Calif., when the Riverside company took it over about June 1st, 1923.

This plant had two 8 x 125 ft. kilns in operation, with Gates ball and tube mills on the raw side and one 726 Allis-Chalmers compeb mill on the finish end, which at that time had just been in operation for about a month to replace two Gates ball mills and three Gates 6 x 16-ft. tube mills, as the Golden State company had in hand the preparation of plans for increasing the plant, which included the installation of two more compeb mills on the finish end, the erection of two new large kilns, the lengthening of the old kilns

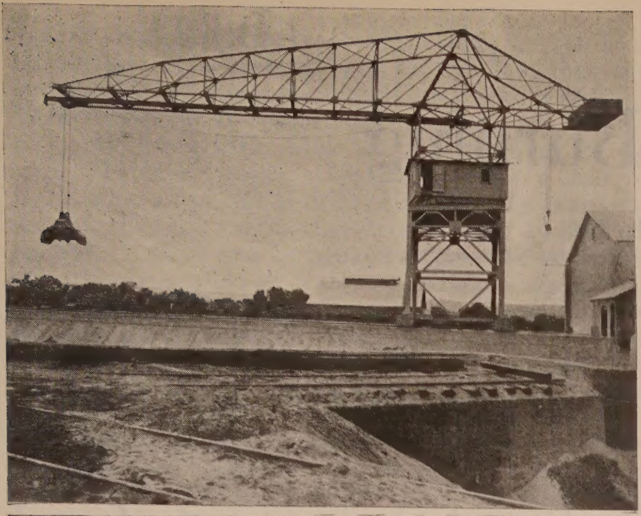

Fig 3—Traveling Hammerhead Crane Serving Clinker Storage

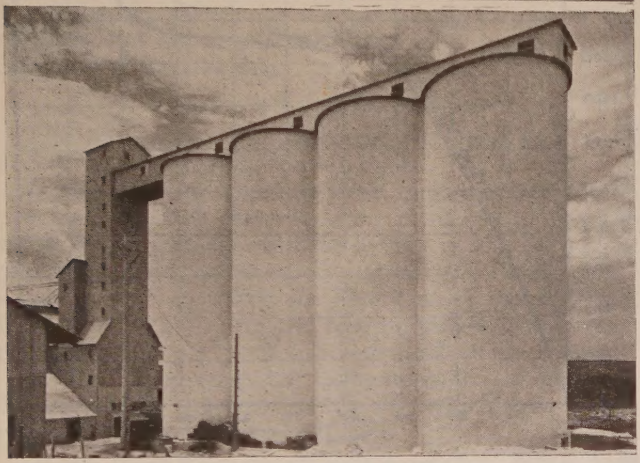

Fig. 4—New 75,000-Bbl. Silo Cement Storage

with enlarged clinkering ends, and increase of the raw end with the mills from the finish end.

The program laid down by the Riverside company comprised:

An increase of kiln capacity to 5,000 barrels per day with like increase of the grinding capacity.

The building of a 15,000-ton crushed stone storage.

A new compounding and mixing department on the raw end.

A new and larger transformer and electric shop building and new cables.

A 300,000-gal. fuel oil storage tank, pumps and oil line.

A 75,000-bbl. silo cement storage warehouse.

A 90-ft. boom revolving derrick crane for clinker storage and handling, similar to the larger one at Riverside plant.

A new and larger boiler and kiln blower house.

The installation of a 36-in. preliminary gyratory crusher belt and rotary grizzley, together with a No. 6 Gates crusher to supplement the No. 7½ crusher already in place, pending the installation of the larger crusher, and to be used in conjunction with it as a secondary.

The increase in size of all conveyors and elevators, standardizing them with those at the Riverside plant.

The substitution of direct connected motors and speed reducers for the multiplicity of shafts, belts, etc., then in operation.

And, finally, to serve the enlarged plant with an entirely new track system, as the original trackage was entirely inadequate.

This program was, of course, entirely too extensive for completion by September 1—the time set for the increased production to be available.

Investigation disclosed the fact that neither the necessary kilns or grinding machinery could be delivered by the manufacturers before September 1, so the work was concentrated upon the points having a direct bearing upon the production of clinker.

By reference to the drawing of the original plant it will be seen that there was a limited space between the railroad track and the kilns. This space could be used for three kilns of same size as those in operation, but not five. It was then decided to place three there in battery with the original two, put them in production, and locate No. 6 and No. 7 kilns at right angles to that battery, where shown by the drawing of the plant as now completed.

The additional kilns were built in the shops of the Riverside Portland Cement Co., with the exception of the steel tires and castings; three of them erected with feed bins, elevators and coolers, all made in the Riverside shops; the raw department changed over, additional raw ball and tube mills installed, the new stone storage built and filled in time to begin production of clinker with the new kilns the first week of September.

The capacity of the compeb on the finish end was, of course, not sufficient to grind the additional clinker then produced, so it was sent to the Riverside plant for finishing. The Riverside plant has an excess of grinding capacity owing to the greater efficiency of metal grinding media over the old flint pebbles in the tube mills, and it could easily take on the additional production that this program called for.

The finish end now consists of, in addition to the one compeb mill, two Gates and two Krupp ball mills, three 5-ft. x 22-ft. Gates tube mills, and two 6-ft. x 24-ft. compartment mills. The four ball mills are equipped with coarse screens, the output passing over a battery of Hummer screens, all 20-mesh material going to the three tube mills, and the rejections to the two compartment mills, which have 2-in. balls in the preliminary compartment.

The Riverside company some time previously acquired the plant and property of the Arizona Portland Cement Co., near Phoenix, and has in the course of preparation plans for an entirely new plant to be built at that place. This put them in possession of additional ball and tube mills that were immediately available for addition to the finish end of the Oro Grande plant. These units and the large gyratory crusher ready for immediate delivery, together with the 6-ft. x 24-ft. compartment mills, and the fact that the Riverside plant shop could turn out much of the structural steel and bin work, were large factors in the rapid progress of the work, and in the decision to discard the plans for enlargement already well advanced by the Golden State company.

When the demon of time limitation rides day and night upon the shoulders of those in charge of construction of this character, it develops resourcefulness in the utilization of such things as are immediately available, and in this connection, as an illustration it may be interesting to state that the stack for one of the new kilns is one of the 70-ft. kilns from the Phoenix plant, and which was one of the two kilns that made the cement used to construct the famous Roosevelt Dam, and two are 6 x 70 ft. shells of old clinker coolers from the Riverside plant that had not been in use for a number of years. All of these shells were at hand and make splendid stacks.

Cement Burning

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The writer has been asked to open a discussion on the subject of the proper design and operation of the rotary cement kiln and the idea of the present paper is rather that of getting the ideas of other cement mill engineers and superintendents on this than to present the subject of cement burning in any very logical manner. His aim will be to touch on some of the points of the controversy and not to attempt a complete exposition of the subject.

As a preliminary to the discussion of the various factors which enter into the burning of cement, it may be well to give a short summary of what takes place in a rotary kiln and what is sought to be accomplished in this.

Reactions Which Occur in the Kiln

The reactions which occur in the burning of cement clinker have been quite carefully studied by Rankin at the United States Geophysical Laboratory. On entering the kiln the mixture is first dried, next the carbonates are decomposed and the sulfur and organic matter burned away. When the hot mixture of lime, silica and alumina enters the clinkering zone there are first formed those silicates and aluminates of lime which form most readily. These compounds are $5\,CaO.3Al_2O_3$ and $2CaO.SiO_2$. These are probably formed in the order given, since the aluminate melts at a lower temperature than the silicate. These two compounds then unite in part with more lime to form the tri-calcium silicate and the tri-calcium aluminate.

At the temperature obtained in the ordinary cement kiln, the compound $5CaO.3Al_2O_3$ will completely change to the compound $3CaO.Al_2O_3$. The compound $2CaO.SiO_2$, however, is not completely converted to the compound $3CaO.SiO_2$, partly because there is not sufficient lime present to form the latter compound.

Our present knowledge of the composition of portland cement is not sufficient to let us say with certainty as to what proportion of the final clinker *should be* di-calcium silicate and tri-calcium silicate respectively. In most commercial cements, however, the two silicates *are* present in about equal quantities. We do, however, know that free lime should not be present to any extent and that the reaction in the kiln should be carried to the point where practically all of the free calcium oxide has united with di-calcium silicate to form the tri-calcium silicate. Whether it would be of advantage to carry a higher percentage of tri-calcium silicate is a point which must be proved. Originally it was supposed that the larger the amount of tri-calcium silicate present in cement the higher the quality of the latter. Recent investigations, however, attribute to the di-calcium silicate certain desirable qualities.

To sum up there are two important series of chemical reactions to be effected in the kiln:

1. The decomposition of the carbonates of lime and magnesia into the oxides of these two metals.
2. The recombination of these oxides with silica and alumina to form the three essential compounds of portland cement—tri-calcium silicate, tri-calcium alumminate and di-calcium silicate.

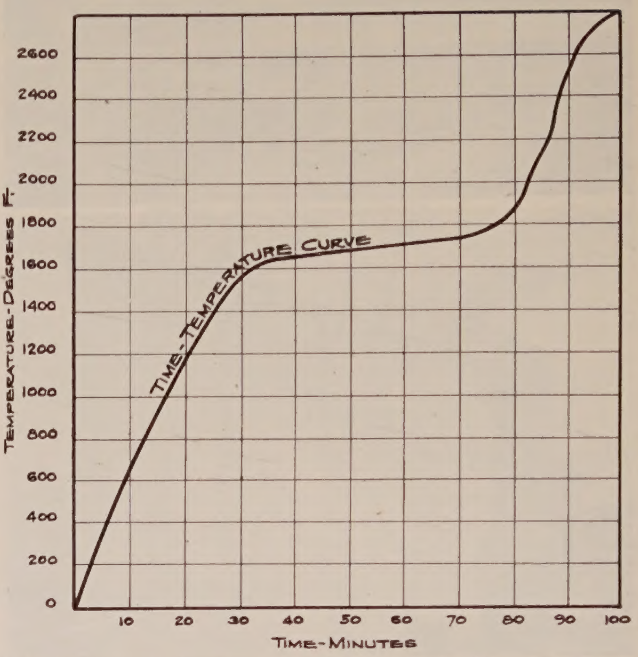


Fig. 1—Diagram Showing Time-Temperature Curve in Clinkering Cement Raw Material

Thermal Reactions in the Kiln

The first reaction requires heat, the second reaction gives off heat. The first is, therefore, *endothermic*, the second *exothermic*. Both reactions occur at what is known as a critical temperature and neither one will take place until this temperature is reached. To decompose calcium carbonate into lime and carbon dioxide there will be required 813 B.t.u. per pound of calcium carbonate burned. To decompose magnesium carbonate into magnesia and carbon dioxide there will be required 631 B.t.u. per pound of magnesium carbonate. To carry out the first reaction in the ordinary cement mix containing approximately 75% carbonate of lime and 4% of carbonate of magnesia there will be required approximately 634 B.t.u. per pound of raw material burned or 950 B.t.u. per pound of clinker formed.

The heat liberated by the reactions in which the silicates are formed is variously placed by different investigators at between 180 and 745 B.t.u. per pound of clinker formed. The average of several recent investigations places the figure at around 200 B.t.u. As the methods employed by these latter investigators were quite different, the last figure is probably near the truth.

In addition to the above main reactions, there are various minor ones which require or give off small amounts of heat, such as the oxidation of the organic matter, iron and sulfur and the combination of the latter with the lime to form calcium sulfate, etc., (which reactions give off heat) and the liberation of combined and hygroscopic moisture (which requires heat to be supplied).

If we place a quantity of cement raw material in a crucible and insert a pyrometer into this and then heat the crucible at a uniform rate we will find that the temperature will rise quite rapidly up to about 1650°F. When this point is reached the temperature remains stationary for a little while and then begins to rise again. In other words, when we first apply heat to the crucible all of this is utilized to raise the temperature of the mix until that temperature (1650°) is reached at which the carbonates begin to decompose. After this for a while all of the heat which is supplied to the material is utilized in decomposing the carbonates into lime and magnesia. When the decomposition is complete, the effect of the heat is again to raise the temperature of the material gradually until the point (approximately 2500°F.) is reached when the lime combines with the silica and alumina when the temperature will begin to increase very much more rapidly. This more rapid increase is due to the additional heat which is supplied by the second reaction or the forming of the silicates and aluminates of lime. The diagram given as Fig. 1 illustrates this.

The Four Zones

The kiln may be roughly divided into four zones according to the work done in each:

In the first zone, the mix is being heated to the temperature at which the carbonates decompose. Various secondary reactions occur here, such as the burning of the sulfur and the organic matter in the mix both of which give off heat and the liberation of the combined water and moisture in the raw materials, which reactions take place at comparatively low temperatures.

In the second zone, the carbonates are decomposed. This occurs in that part of the kiln which is at a temperature of approximately 1650°F.

In the third zone, the material has been freed from its carbon dioxide and is being heated to the temperature necessary for the formation of the aluminates and silicates of lime.

In the fourth zone the cement clinker is formed—that is, the silicates and aluminates of lime.

It must not be supposed that these zones in the kiln are separated by any well defined line. They unquestionably overlap and some of each reaction takes place in the adjacent zones.

Roughly speaking, we may consider 25% of the length of the kiln as used to heat the material up to the point at which the carbon dioxide is driven off, 50% of the kiln is utilized largely to drive off carbon dioxide and heat the calcined material up to the clinkering temperature, while 25% constitutes the clinkering zone.

To carry out the first series of reactions, namely the breaking up of the carbonates, it is necessary for heat to be supplied to the raw material at the rate of approximately 950 B.t.u. per pound of clinker.

To carry out the second reaction, the forming of the silicates, however, it is only necessary to heat the materials entering the burning zone up to a temperature of approximately 2500° and to maintain them at this temperature or at higher temperature until the three compounds are formed. During this time the materials themselves give off 200 B.t.u. per pound of clinker.

Relation Between Time, Temperature and Fineness

The first reaction, is a rather commonplace one, which is well understood as it occurs in the burning of lime, etc. The second reaction is more complex. The materials are never actually melted and the combination is brought about by the intimate contact between surfaces. This is effected by three things, the amount of surface exposed, or in other words the fineness, the temperature at which the material is heated and the time during which this temperature is maintained. These three conditions are intimately associated. With very finely ground material the combination will take place at a lower temperature or with less heating than where materials are coarsely ground. With materials of the same fineness the combination will take place more rapidly where the temperature is higher; conversely the time required to bring about the combination will be the longest where the temperature is lowest or the grinding insufficient.

The writer has been in the habit of expressing this relation in the form of a mathematical formula.

$$D \times T \times F = C$$

In which D represents time, T temperature, F fineness and C a constant, namely clinker. If we increase any one of the three variables, D, T or F, it will decrease one or both of the other two; thus by increasing the time in the kiln we decrease the temperature necessary to clinker or the fineness, while, if we grind the materials more finely, we decrease either the temperature or the length of time in the kiln and may thus increase the output of the kiln or decrease the fuel required per barrel. This equation does not take care of the chemical composition of the mix and is intended to express rather the physical than the chemical relations in burning. It has been both practically and theoretically demonstrated that this condition does exist in cement burning and I think in any discussion of the rotary kiln this relation should be kept constantly in mind.

To keep this relation in mind, therefore, in an investigation of burning conditions, attention must be paid to the fineness of the raw material, the length of time in the clinkering zone, temperature of the flame, etc.

Source of Heat

In a cement kiln, our object is to apply the latent heat in the fuel to decompose the limestone. This is done by burning the fuel and passing the products of combustion over a body of the cement raw material. The transfering of heat takes place from the gases to the cement mix and to the walls of the kiln, the heat being transferred from the latter again to the mix; so that the mix is heated in two ways—by the products of combustion directly and through the walls of the kiln.

The first step in the burning of clinker is, of course, the source of heat. Pulverized coal is used at by far the greater majority of plants. Fortunately in this fuel we have one which is susceptible to very nice regulation and which can be burned with practically the exact amount of air theoretically necessary for combustion. We do not, as is the case with grate and stoker firing, have to consider the condition of the fuel body, etc. with reference to supplying the oxygen to burn the fuel. Nor do we have to consider carbon or unconsumed coal carried out by the ash. Analyses of kiln gases show that in the great majority of cases the coal is burned either with a slight deficiency (a reducing flame) or with a very small excess of air (an oxidizing flame); in other words with practically the theoretical amount of oxygen necessary (a neutral flame).

Fortunately in a cement kiln we do not, as in metallurgical furnaces, have to consider the chemical qualities of the flame, and so far as the essential chemical combinations and decompositions to be effected in this are concerned, these take place equally well in a reducing or an oxidizing atmosphere, consequently our concern is chiefly toward burning the fuel efficiently and in such a manner that its heat energy may be most effectively utilized.

Temperature

The greatest factor in determining the temperature of the flame is the amount of air used for combustion, thus if we burn one pound of coal with just the quantity of air necessary for combustion, the gases produced would weigh about 11 pounds. If we use twice as much air as is necessary the products will weigh 21 pounds. Manifestly if we transfer the heat of one pound of coal to 11 pounds of gas the temperature of the latter will be much higher than if we transfer the same quantity of heat to 21 pounds of gas.

The temperature of the flame unquestionably has a great influence on both the economy and the chemistry of cement burning. Aside from the fact that with higher temperatures in the kiln less time is required for burning or a coarser raw material may be used, it is well known that the rate of heat transfer is proportional to the difference between the gases and the material to be heated, other conditions remaining constant, hence the higher the flame the more rapidly the heat can be transferred to the mixture.

There is another objection to excess air. Some heat is always carried away by the gases leaving the kiln. This heat is proportional to the quantity and temperature of the gases. Eleven pounds of gas leaving the kiln will carry off only about half the heat which will be carried off by 21 pounds. This applies whether we use waste heat boilers or not, and the relative percentage of heat carried off by the gases will be the same whether they are at a low or a high temperature—that is to say, at the same temperature 11 pounds of gas will carry off only half as much heat as 21 pounds, whether the temperature of the exhaust gases is at 400°F. or 1600°F. It would seem, therefore, as if to promote the efficiency, the excess air used for combustion should be reduced to a minimum.

Relation Between Kiln Lining and Temperature

There is a very practical point in connection with the temperature of the kiln which must be considered and that is the ability of the lining to stand the temperature. As a matter of fact, however, the lining not only has to stand the temperature, but also the chemical action which occurs between lime and the aluminates from which fire-brick is made. This affinity is marked at high temperatures.

This brings up the point of the possibility of using another lining for the kiln rather than the ordinary high alumina fire-brick. In the early days of the industry, the rotary kilns were lined with magnesia-brick. This lining was succeeded by the present lining of high alumina fire-brick. The question naturally presents itself as to whether any better results would be obtained by the use of other brick. Great improvements have been made in the manufacture of fire-brick of a very high degree of refractoriness. It is possible that cement manufacturers may be overlooking something and that better results might be obtained than is now possible by the use of some of these materials. This is a point which, however, can only be determined by experimenting.

At most plants, the burning is done on what is designated as a "coated kiln," that is the burning zone of the kiln is coated with the raw material, the latter being made to adhere in a thin layer by fusing with the brick. When this coating falls a small amount of brick at the joint is carried away and consequently it is desirable to prevent any damage to the coating. This is very susceptible to changes of temperature and if long service is to be obtained from the fire-brick in the clinkering zone, the temperature here should be kept reasonably uniform and the shutting down of the kiln avoided. The latter is most destructive of the lining, as it usually results in a considerable proportion of the coating falling.

Preheated Air

It is, of course, understood that the temperature of the flame can be increased by using preheated air. This is quite common in blast furnace practice. Even where high temperatures are not desired the sum total of heat introduced into the kiln will be increased by whatever heat is in the preheated air. This naturally brings up the question of coolers.

Theoretically the amount of heat carried out of the kiln by clinker at the temperature of its formation, or say 2550°F., is approximately 246,000 B.t.u. per bbl. of clinker, or approximately the heat equivalent to 17½ lbs. of coal. It must be remembered, however, that clinker does not leave the kiln at the temperature at which it is formed. The burning zone hardly ever extends entirely to the end, and the last 4 or 5 feet of the kiln really acts as a cooler. My experience has been that clinker usually leaves the kiln some 400 or 500° below that at which it was formed, or say at about 2000°F., so that the heat carried off by the clinker is never more than about 80% of the above figure. However, even the latter represents a considerable amount of heat carried off by the clinker.

Coolers or Not?

This naturally brings up the question of rotary coolers so placed below the kiln as to preheat the air entering the latter and whether these reduce materially the quantity of coal employed for burning. The writer's own experience is somewhat at variance with theory and he is perfectly frank to say that where he has installed coolers they have not been able to show anywhere near the economy which he expected and it is with him still a disputed point, whether it is worth while to install them or not. With the modern clinker storage, the cooler does not appear to be necessary for cooling and handling the clinker and the question which needs an answer is whether the cooler saves sufficient heat to warrant its installation.

It must be remembered that with the rotary cooler not all the cooling is done by air and that there is unquestionably a considerable dissipation of heat by radiation from the shell of the cooler. It is quite possible that this radiation loss is very much greater than one would suppose. In some instances too, the full volume of air entering the cooler is not discharged into the kiln and in this event, of course, the ability of the cooler to save fuel is reduced by just so much. Of course, where the cooler is attached to a stack and the air passing through the cooler is discharged directly into the atmosphere, they are of no value as fuel savers; and if this is done, a cooler is probably not worth installing, except where clinker storage can not be employed.

Length and Diameter

The ratio between length and diameter is pretty well understood and we have had a general lengthening of kilns during the last two decades. In many instances, however, the diameter of the kiln has also been increased with the result that efficiency has not been bettered. The theory of the long kiln is that the greater the length of the kiln the more opportunity will be given to the materials to absorb the heat from the products of combustion; and to a lesser degree, greater time will also be given to effect the recombination of the oxides with the silica and alumina to form the calcium aluminates and silicates. The smaller the diameter of the kiln the more intimately are the gases brought in contact with the material both directly and through the medium of the walls of the kiln. If a kiln 60 ft. long is increased to 100 ft. an immediate fuel economy will be effected. If at the same time, however, the diameter of the kiln is also increased very little, if any, saving in fuel will be obtained. In fact, if the diameter is increased too much an actual increase in the quantity of fuel required to burn a barrel of cement will be required.

Unfortunately there is a structural objection in making kilns of small diameter and great length and generally in order to obtain a kiln which is mechanically satisfactory it is necessary to increase the diameter to some extent as the length is increased.

In comparing kilns, therefore, it seems to me to be well to consider the ratio between the length and either the circumference or the area of the unlined section of the kiln, that is, in a kiln 8 ft. in diameter by 125 ft. long with a 6-in. lining the ratio between the length and the circumference would be as 125 is to 22, or 5.8:1; or compared with the area as 125 is to 38.5 or 3.25:1. This would possibly give us a better method of comparing kilns than that ordinarily used.

Inclination of the Kiln

The inclination of the kiln affects, of course, the rapidity with which the material travels through the former, other things being equal. The speed with which the material travels is also affected by the rate at which the kiln is rotated. But if two kilns were inclined, one say at an inclination of ¾ of an inch to the foot and the other ½ of an inch to the foot, the material could be made to travel through both at practically the same rate of speed by revolving the latter much faster than the former. On the other hand, in the case of the flatter pitch, the kiln would carry a much larger body of material and consequently the material would remain in the kiln for a longer time. This point is worth considering where trouble is experienced with the soundness of the cement, as by increasing the time in the kiln a more effective combination of the lime with the dicalcium silicate can be effected.

Length of Clinkering Zone

The length of the clinkering zone should receive some consideration in connection with the points just brought up, as this gives a longer time for the formation of the clinker. The temperature of the flame, the inclination of the kiln, the speed of rotation and the length of the clinkering zone all bring us back to our formula of $D \times T \times F = C$.

The lengthening of the clinkering zone is largely a matter of the draft, that is to say of the velocity of the gases passing through the kiln. Theoretically the fineness of the coal, the percentage of volatile matter in this and the thoroughness with which the air for combustion is mixed with the coal should all have some effect on whether the flame is short or long. In practice, however, the length of the clinkering zone is usually regulated by the doors in the stack chamber or the fan at the waste heat boilers. It would be interesting to hear whether the coarser ground coal, or coal lower in volatile matter has increased the length of the clinkering zone and what effect various manufacturers have had with burners designed to give better mixing of air and coal or using more or less air for carrying in the coal than is the usual practice.

Radiation Losses

It has become quite the practice of late to decrease the heat radiation from the shell of the kiln by interposing between the fire-brick and the latter some heat insulating material such as Sil-O-Cel. This material should cut down very materially the radiation loss. Unfortunately, however, it cannot be used in the clinkering zone. If used here the effect of confining the heat to the lining is to rapidly destroy the latter. This is unfortunate because it is in this part of the kiln that the greatest radiation occurs, since radiation varies directly as the temperature. The cement manufacturer, however, is not as badly off as the iron manufacturer. In the blast furnace it is necessary to place water cooled plates next to the fire-brick in order to prevent destruction of the latter.

In connection with these heat insulating materials it would be interesting to know whether anyone has any direct information showing just what saving of fuel *has* been effected, and also whether the saving is the same if waste heat boilers are employed or not.

Chemical Composition

In comparing kilns at various plants it is probable that the hardest condition to reconcile is the variation in the materials themselves. It is quite evident to those who have had experience at several cement plants that some materials burn very much more easily than others. It is not always simply a question of the amount of lime which is carried in the mix. A great many other chemical conditions affect the burning, such as the amount of iron oxide, alkalies, etc., present in the raw materials.

The most important condition which affects the amount of fuel used in burning is, of course, whether the wet or the dry process is employed. Owing to the large amount of work which is done in the preheating zone of the kiln in the wet process, it is very hard to compare these two. The relative amounts of work to be done in each instance are given below.

	Heat required—B.t.u. per bbl.	
	Dry Process	Wet Process
To heat water to 212° F.	13,100	65,600
To evaporate water	58,200	291,120
To decompose carbonates	380,400	380,400
To heat mix from 50°—1650° F.	211,200	211,200
To heat mix from 1650°—2550° F.	79,200	79,200
Total	742,100	1,027,520

From the above it will be seen that the condition of burning in the wet process is somewhat different from that in the dry.

In the wet process the kiln has really five zones—one of which may be considered as an evaporator, in which the evaporation of the water takes place and in which the temperature of the mix (not gases) is approximately 212°F. We then have the second zone which corresponds to the first zone in the dry process kiln, etc.

In comparing the performance of wet process kilns, therefore, it is highly important to know the percentage of water in the slurry. Some materials require more water than others in order to make a slurry which can be handled properly, and the more water present the more fuel will be required in burning, other things being equal.

It seems to me that in any discussion of rotary kiln operation, these points should receive consideration:

1. Are kilns operated to obtain maximum output or to reduce fuel consumption per barrel
2. Size of kiln
3. Design of kiln—straight or bottled
4. Thickness of lining and is burning zone on coated or uncoated brick
5. Inclination of kiln
6. Observed length of the clinkering zone
7. Average speed at rotation
8. Draft at base of stack and at front end of kiln
9. Is cooler employed and if so does all heated air from this enter kiln
10. Fuel employed
11. Percentage of air necessary for combustion admitted with fuel
12. Size of burner pipe, pressure and velocity of air and coal blast in this
13. Fineness of raw material
14. Wet or Dry Process. If wet process amount of water in slurry
15. How does material burn—chemical characteristics
16. Is feed of raw material to kiln regular or irregular

The Automatic Shaft Kiln For Cement Burning

By Dr. Frans Killig
Superintendent, Olands Cement Co., Degerhamn, Sweden

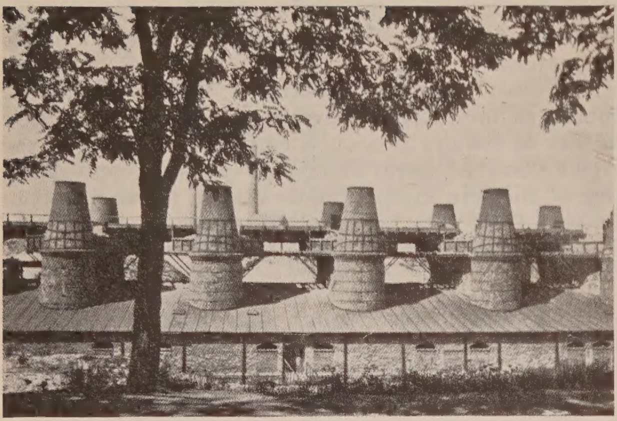


Fig. 1—Series of Ancient Shaft Kilns at a German Plant

The invention on which the production of cement is based was realized by means of shaft kilns. The enormous progress of the cement industry at the turn of the century would never have been possible, however, but for the rotary kiln, a furnace which made it possible to produce great quantities of well-burned clinker, simplifying the whole manufacture, and did away with many of the difficulties inherent in the old type of kilns such as interruptions in the operation and incomplete performance of the burning. There is, however, a weak point about the rotary kiln—the fuel economy. The enormous amount of heat lost by the waste gases is a tremendous item, which nevertheless was ignored so long as it was compensated by the low fuel prices and the mass production of high class cement in the rotary kilns.

It is only since the price of coal has gone up, and the competition between works operating with rotary kilns has become more severe that efforts have been made to utilize the waste gases of this type of kiln. The methods tried to effect this result have been of various kinds and of varying success, and a thoroughly rational way of recovering the waste heat has not yet come into general use. The waste-heat boilers may certainly be regarded as a step in the right direction, but they do not by any means represent the final solution of the problem.

The difficulties to be surmounted have been amply acknowledged even earlier, and this is the reason why the interest reverted to the old shaft kiln. It is quite true that it could not compete with the rotary kiln either in the matter of automatic working or quantity and quality of the clinker but it is greatly superior as regards fuel economy. The question was not raised by the manufacturers of cement machinery but by the cement industry. Most of the old European works had in the beginning equipped their plants with shaft kilns for the production of cement. The latter were later replaced by rotary kilns, but the shaft kilns were ordinarily left standing side by side with the modern kilns, as in Fig. 1. The first successful plan to make the shaft kilns more efficient, was that of Prof. Hauenschild, managing director of the cement works at Beoscin, Austria, who designed the first automatic shaft kiln. He equipped an ordinary straight Schneider shaft kiln with a horizontal round rotary grate in the discharge opening, which it filled completely. Here the grate rotated very slowly around a vertical spindle, and by such means the most troublesome work in connection with the old kilns, viz., the emptying of the kiln, was done mechanically. The operation of the kiln was at the same time made more uniform resulting in the clinker being improved and the output increased. The introduction of compressed air above the discharge opening, automatic charging of the raw material, which had been briquetted in presses close to the kiln, and automatic transportation arrangements still further increased the output of these modernized kilns.

The foregoing are the principal features of the automatic shaft kilns.

The patent taken out on the first design was later

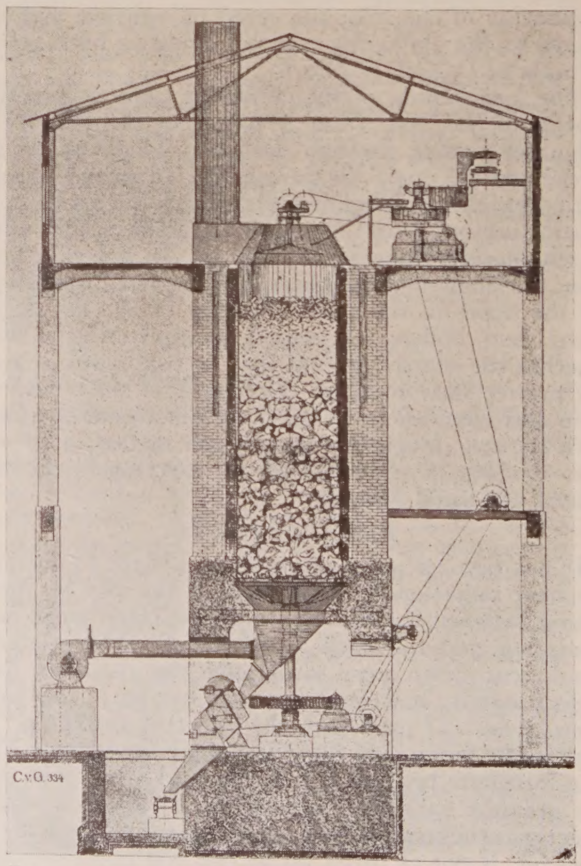
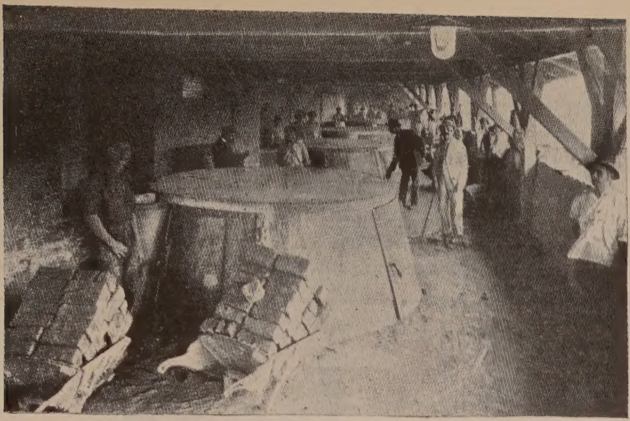
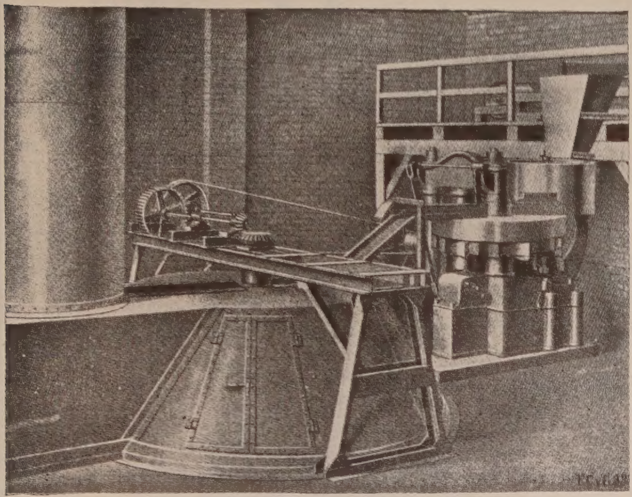


Fig. 2—The First Type of an Automatic Shaft Kiln; The Grueber Kiln





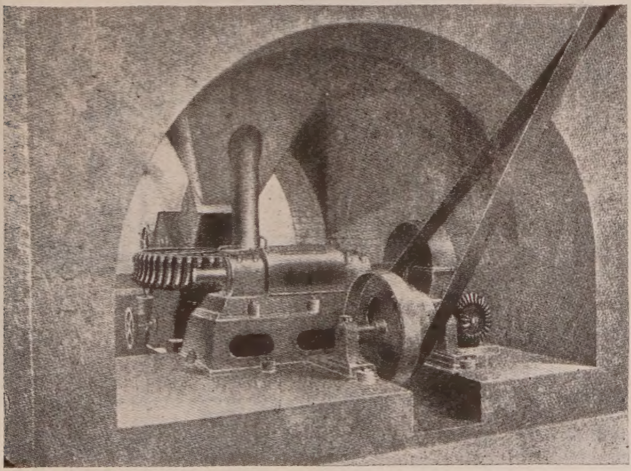


Fig. 3—The Charging of Ancient Shaft Kilns. All Labor Done by Hand

Fig. 4—The Charging of an Automatic Shaft Kiln, Showing the Briquetting Press beside the Kiln

Fig. 5—The Worm Gear and Vertical Spindle Moving the Rotary Grate

acquired by the firm of C. von Grueber, Berlin, which perfected the mechanical equipment to the point of making the operation automatic throughout. See Fig. 2. The so-called Grueber kiln is composed of a vertical shaft of the characteristic type for Schneider kilns, approximately 11 meters high. All hand labor is replaced by machines saving the principal costs of ancient manufacturing shown in Fig. 3. The raw material is supplied to the kiln in the form of briquettes, consisting of raw powder and coke dust mixed and moistened in special mixing machines. The briquetting is done in rotative table presses placed very close to the kiln as shown in Fig. 4. The briquettes are conveyed into the kiln and distributed over the diameter of the shaft automatically. The burning zone is situated about half way up the shaft. The charge is preheated by the waste gases, passes through the fire, is then cooled by the ascending blast, produced by a fan and leaves the shaft by way of the rotating grate which incidentally breaks up the mass. The grate is moved very slowly by a worm gear consuming ½ to 1 h. p. It can be moved by hand. The clinker is collected in a hopper beneath the grate, and passes through two small chambers alternately closed and opened by shutters, which are worked automatically. Their object is to prevent the blast from being ejected through the hopper. The clinker is removed by means of a conveyor. The output of a kiln of this description, of an average diameter of from 2 to 3 meters, is from 250 to 300 barrels of cement in 24 hours, i. e. from 3 to 4 times as much as that of an old-type shaft kiln operated with hand power.

This brilliant result served to turn the attention of cement manufacturers to the old-time shaft kilns. Different plans for rebuilding them were carried out as a result of investigations made, and below we shall give a brief account of some designs that have also proved advantageous.

The firm Polysius at Dessan has created another type of rotary grate without vertical spindle, the grate being fixed directly upon the worm gear (Fig. 6.)

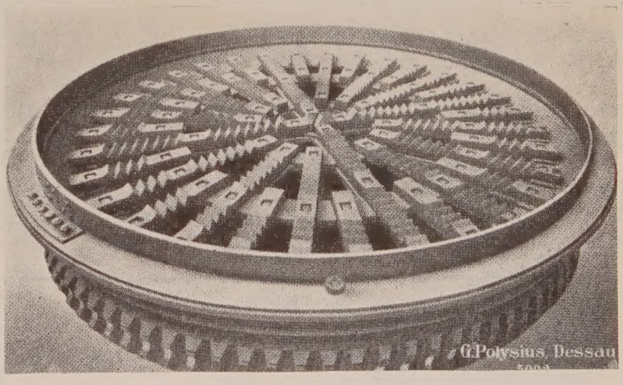


Fig. 6—The Polysius Grate without Spindle

The firm Barbarossa-Works at Kaiserslauten fits its automatic shaft kilns with a grate, called a Thiele grate after the inventor. It consists of two sections of toothed bars, which are moved horizontally by a worm gear back and forth underneath the discharge opening (see Fig. 7) and crush the clinker and allow it to pass through the grate.

The firm Amme, Giesecke & Konegen at Braunschweig has replaced the grate by two horizontal

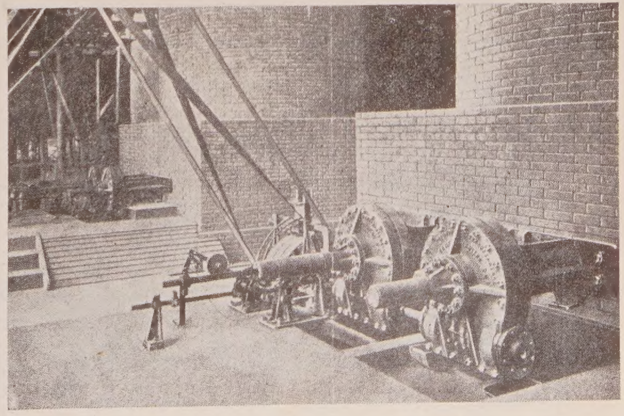
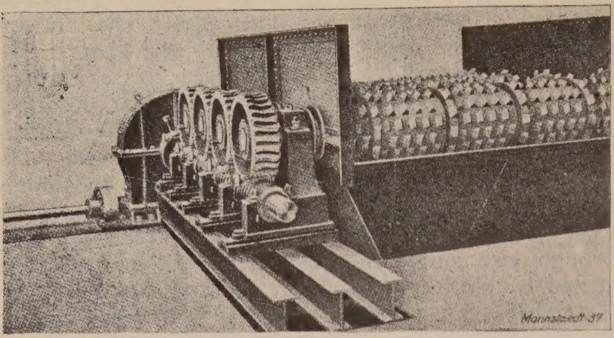


Fig. 7—The Worm Gear Underneath a Kiln of Barbarossa Works



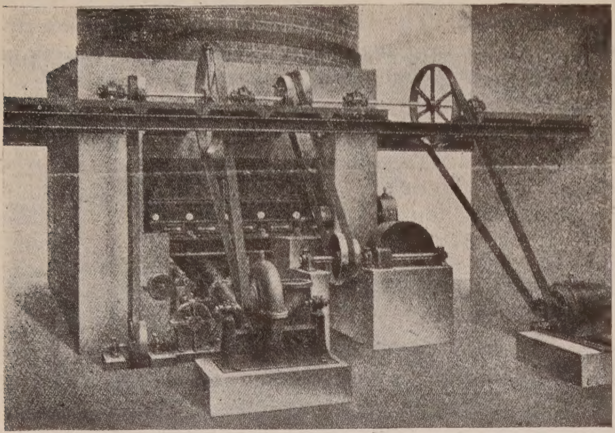


Fig. 8—The Grate of a Mannsteadt Kiln
Fig. 9—The Mannsteadt Kiln: Hopper, Worm Gear and Fan

rolls underneath the shaft, which serve to remove the clinker.

A type of grate very extensively employed for shaft kilns is the one designed by the firm Mannsteadt-Werke at Troisdorf, Cologne. It consists of four toothed rolls placed horizontally underneath the shaft and across the entire lower opening (see Figs. 8 and 9.) The device employed by this firm to keep the blast from issuing when the clinker is being discharged is of special interest. Fig. 10 shows the lower part of the kiln with bearings for the four rolls and the hopper in which the clinker is collected, the hopper ending in a cylindrical container having a cone-shaped bottom, which is like a valve seat. This cone can be raised which lets the clinker down into another container also fitted with a cone bottom. The lower cone is opened only after the top one has been closed and has shut off the upper container. This type of kiln, Fig. 11, has proved very practical, a recently built kiln with Mannsteadt grate at a South-German cement works having an average output of 420-480 bbls. of cement in 24 hours during a period of six months.

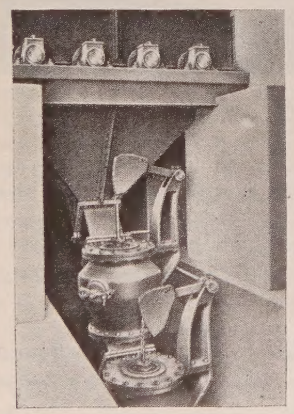


Fig. 10—The Lower Part of a Mannsteadt Kiln, Hopper and Shutter Apparatus

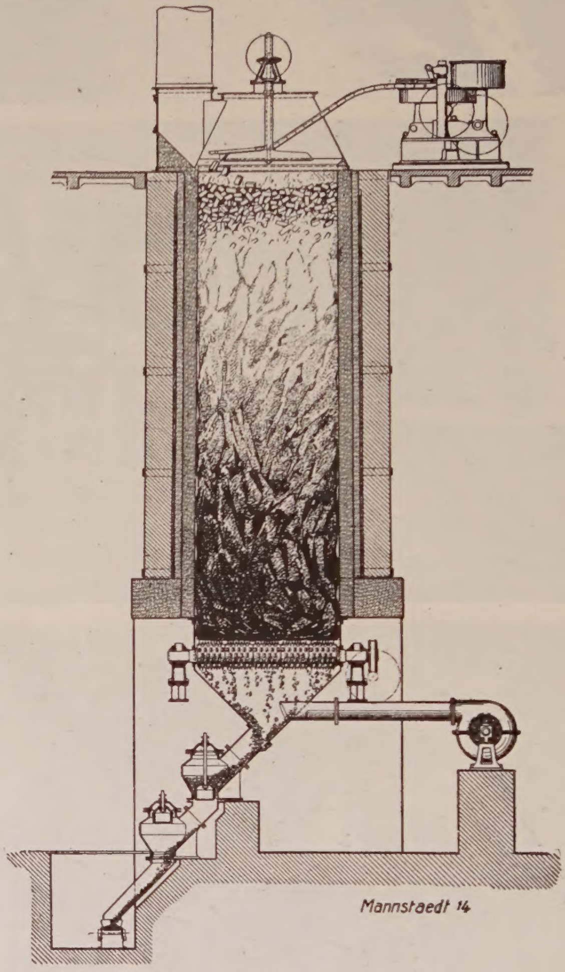


Fig. 11—The Mannsteadt Kiln

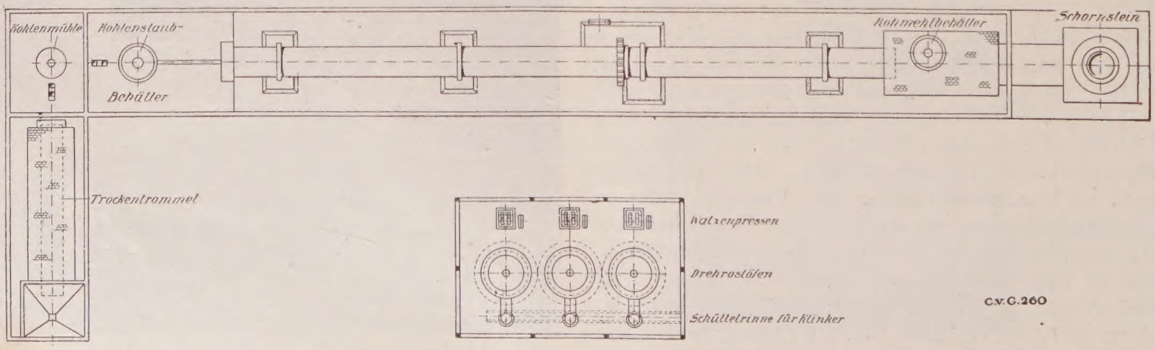


Fig. 12—A Rotary Kiln, 1000-Bbl. Production Compared with a Set of Shaft Kilns, 1000-Bbl. Production

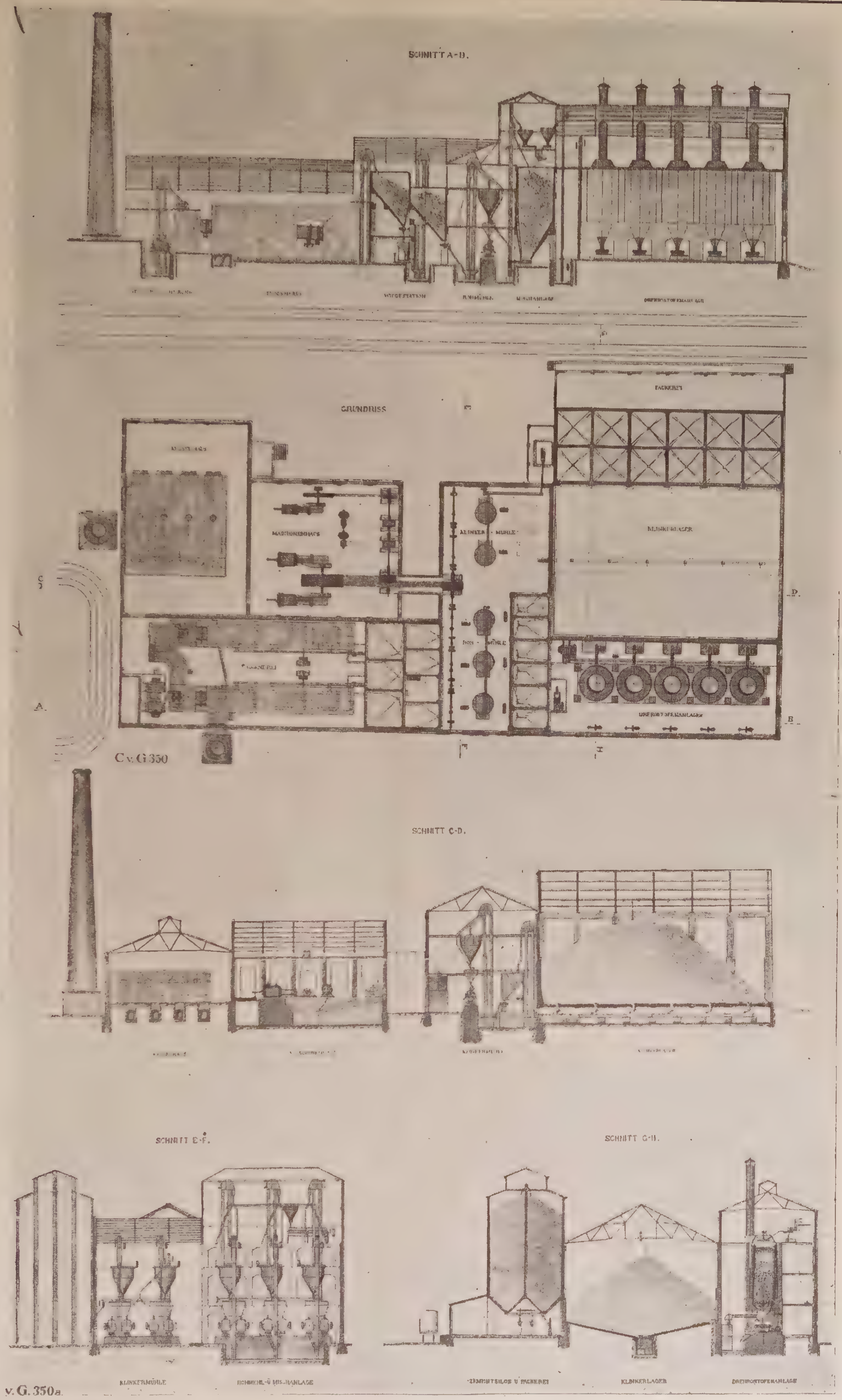


Fig. 13—Layout of a Plant Operating with 5 Automatic Shaft Kilns, Producing 500,000 Bbls. per Year

The result with a kiln of 2.75 meters diameter must be looked upon as unique.

Besides the above mentioned grates a great many other types have been designed, partly of the roll and partly of the flat grate scraper and crusher type. Only a few of these have turned out serviceable, and the majority must be regarded more or less as attempts to circumvent the original patents both in the matter of the actual grate and the closing and shutter device. Among the multitude for which patent has been asked are both good and merely curious designs.

No attempt will be made here to decide which of the various grate types is the most suitable. The fact that more than 500 automatic shaft kilns have been erected of late years, and that new kilns are constantly being built and old ones remodeled is a proof of the capacity and efficiency of the automatic shaft kilns, and especially in these days of severe competition in the cement market, of their importance to the industry.

The shaft kiln in its new form has undoubtedly become a dangerous rival of the rotary kiln which heretofore has been absolutely supreme in the field. The prime advantages of the rotary kilns over the old-style kilns are the following, viz., mass production of well-burned clinker and automatic operation. Both of these features are embodied in the automatic shaft kiln although the latter certainly cannot come up to a daily output of 1500 bbls. of cement, which is the capacity of a large rotary kiln. But it is possible to attain this figure by means of a series of shaft kilns even if one calculates with only from 300 to 400 bbls. per kiln. The clinker is uniform and thoroughly well burned. Half burned cement need not occur more often than in case of a rotary kiln. The amount of power required is much less than for a rotary kiln plant. The coal-drying and coal-crushing department is entirely eliminated. Great sums are saved in erecting a shaft kiln cement works from the fact that buildings, foundations, machinery, smoke stacks and smoke flues are unnecessary. The illustration in Fig. 12 shows the amount of space needed for a rotary kiln plant as compared with a shaft kiln plant of the same capacity.

The greatest saving, however, falls on the fuel. A rotary kiln requires from 25% to 28% coal; an automatic shaft furnace only from 15% to 18% coke dust thanks to its design which makes it possible to utilize the heat of the fuel down to the vanishing point. Coke dust can be bought for half the price demanded for coal. Power is also saved in the grinding of the cement inasmuch as the clinker of the automatic shaft kiln is usually porous and falls apart in the storage bins. Not more than two-thirds of the power required for grinding rotary kiln clinker is consumed for grinding the shaft kiln product. The foregoing facts are sufficient for the practical cement man to form his own opinion as to the comparative advantages of the two systems of cement production. The figures given here for results have indeed often been surpassed in actual manufacturing.

The plan (Fig. 13) shows the machinery of a cement plant operating with 5 Grueber kilns for a production of 500,000 barrels.

It is generally known that plants operating with automatic shaft kilns have a very low consumption of power and several modern cement plants erected in the last years produce 15–17.5 kg. finished portland cement with 1 kwh., i. e. summary of power for crushing raw mill, kilns with presses and cement finishing—what rotary kiln plant can obtain such a result?

Partisans of the rotary kiln system have often retorted that not every kind of raw material is suitable for the automatic shaft kiln, whereas the rotary kiln will work up all sorts of materials without trouble. This may be true in so far as the objection is directed against the old type shaft kilns, which were only capable of using raw material of good plastic properties. The automatic shaft kiln is not hampered in this way. I have myself managed a cement works where a mixture of limestone and slag was used as raw material. Very little plasticity was present in this composition, and yet the kilns in question turned out an excellent cement. The experience I gained from starting up the first Grueber kilns and the first Mannsteadt kilns—as well as from subsequent operations of these kilns—convinces me that the plasticity of the raw material is of minor importance in operating automatic shaft kilns.

The automatic shaft kiln is of as much importance in the present situation of the cement industry as the introduction of the rotary kiln before the industry was developed. It naturally is not faultless, any more than the rotary kiln, but it is efficient and economical. For this reason, and thanks to its method of working, it has advanced to a conspicuous position not only in the cement industry but also in the magnesite, phosphate and lime industries and allied production. It will retain this place so long as manufacturers are compelled to have plants that are economical and not merely have a great capacity. Only the methods and means that are economical have a chance to survive.

Anti-Dumping Decision Put Off

A thirty-days' extension of time, from July 15 to Aug. 15, has been granted by the Treasury Department to all parties interested in the pending investigation into charges that the anti-dumping law has been violated by importations of portland cement from certain European countries. A hearing in connection with this case, which has been before the Department for more than a year, was held before Assistant Secretary Moss early in June.

While no decision has been reached by the Treasury officials, either as a result of the investigation which has been made abroad by its own agents and by consular officers or as a result of the hearing where both the domestic producers and importing interests were represented, the impression has been gleaned in Washington that the case thus far has not been established as conclusive of proof of dumping.

In addition to the questions of fact which have to be decided, the Treasury Department must reach a decision as to whether the anti-dumping act is applicable where admittedly only part of a domestic industry is affected by conditions complained of. This is the situation in the cement case as it is only the domestic producers along the Atlantic seaboard and in California who have complained of foreign competition. The nature of the domestic industry, with plants scattered throughout the country, is such that the interior producers, being close to raw materials and close to their markets for the finished product, are protected against foreign competition by the natural barrier of freight rates from the seaboard to the markets they serve.—*Engineering News Record.*

CEMENT MILL SAFETY TROPHY

Trophy Emphasizes Cement Mill Safety

Having lost less time from accidents than any other portland cement plant in the country, the San Antonio Portland Cement Co. has been awarded the Portland Cement Association's safety contest trophy. Ninety-nine cement plants participated in the safety contest which determined the winner. The Association will make this contest an annual event, carrying out its policy of cooperating with cement mills to reduce accidents.

The trophy, to be made of cement manufactured at the plant of the winning company, is to be a concrete medallion bearing figures depicting the theme, "Safety Follows Wisdom." Miss Ruth Sherwood, of the Art Institute, Chicago, is the sculptress who designed and modeled the plaque.

The contest itself has been an important contributory factor in reducing the number of accidents in cement plants, according to H. G. Jacobsen, director of the accident prevention bureau of the Portland Cement Association. The cement industry's severity rate in 1923 was 5.411 days lost per 100,000 hours worked, compared with a rate of 6.504 for 1922. This is a marked reduction, whereas other basic industries showed an increase in the severity rate for this period. Fatal accidents were decreased by 30%.

The San Antonio plant, Mr. Jacobsen reports, had only three accidents, which were of a minor character. The plant's record shows that on the average maintained only one day per man in eleven and a half years would be lost on account of accidents. Several other plants gave the Texas mill a close race. Fourteen plants had better safety records in 1923 than did the plant having the best record in 1919.

"No Accident Month" campaigns have been important factors in lowering the severity rate. In these campaigns the different departments of a plant are in competition. By interesting the men in safety work in this manner great improvement has been shown. The serious consequences of carelessness have been pointed out.

In addition to the hazard of running machinery, such as is found in other industries, cement manufacturing has other hazards—explosives used in the quarries, the presence of powdered coal, used as fuel in most cement plants, and the molten stone from the kilns which is transported through the plants mechanically. Though it is generally overlooked, powdered coal is a dangerous explosive, and the fact that this not generally recognized makes an added hazard. Despite the fact that the cement industry is more hazardous than many other industries, it has shown a material reduction of accidents. This demonstrates the efficacy of the contest.

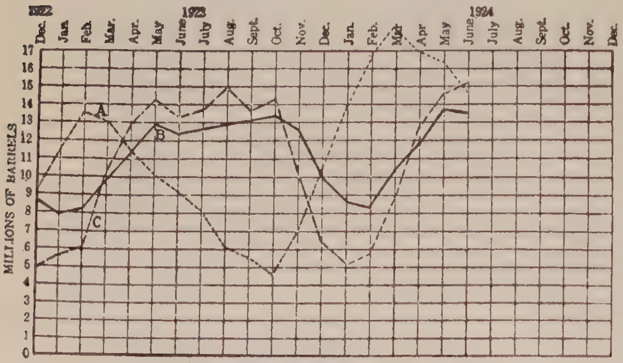
Above all things, the cement companies have aimed to prevent carelessness, the most fruitful cause of accidents, and here the contest has aided greatly.

Power Exposition

Over 260 exhibitors have been assigned space at the Third National Exposition of Power & Mechanical Engineering which will be held in Grand Central Palace, New York City, from December 1 to December 6, inclusive. As this number is more than twice the number who had engaged space on August 1 a year ago, the indications are that the coming event will be of great interest and importance.

The exposition will, as usual, parallel the meetings of The American Society of Mechanical Engineers and the American Society of Refrigerating Engineers. Plans are under way for the American Society of Heating and Ventilating Engineers to have a gathering of local sections during the time of the exposition. The cooperation of the various engineering societies has been valuable, since it enables members to attend the meetings and at the same time see the interesting exhibits at the Grand Central Palace. Fred W. Payne and Charles F. Roth, are co-managers of the exposition with offices at the Grand Central Palace.

Cement Shipments in June Break Record



(A) Stocks of finished portland cement at factories
(B) Production of finished portland cement
(C) Shipments of finished portland cement from factories

The statistics shown in tables issued by the Department of the Interior, and prepared under the direction of Ernest F. Burchard, of the Geological Survey, show that shipments for the month of June, 1924, are the greatest on record, that production is exceeded only by that of May, and that stocks are over 62% higher than in June, 1923.

Stocks of clinker, or unground cement, at the mills at the end of June, 1924, amounted to about 7,618,000 bbls. compared with 8,225,000 bbls. (revised) at the beginning of the month.

PRODUCTION, SHIPMENTS, AND STOCKS OF FINISHED PORTLAND CEMENT, BY MONTHS, IN 1923 AND 1924, IN BARRELS

Month	Production		Shipments		Stocks at end of month	
	1923	1924	1923	1924	1923*a*	1924
January	7,990,000	8,788,000	*a*5,628,000	5,210,000	11,477,000	*a*14,155,000
February	8,210,000	8,588,000	*a*6,090,000	5,933,000	13,596,000	*a*16,815,000
March	9,880,000	10,370,000	10,326,000	8,995,000	13,045,000	*a*18,189,000
1st quar.	26,080,000	27,746,000	22,044,000	20,138,000	....	....
April	11,359,000	11,726,000	12,954,000	12,771,000	11,463,000	*a*17,159,000
May	12,910,000	13,777,000	14,257,000	14,551,000	10,144,000	*a*16,403,000
June	12,382,000	13,538,000	13,307,000	15,036,000	9,168,000	14,905,000
2nd quar.	36,651,000	39,041,000	40,518,000	42,358,000	....	....
July	12,620,000	....	13,712,000	....	8,081,000	....
August	12,967,000	....	14,971,000	....	6,080,000	....
September	13,109,000	....	13,698,000	....	5,533,000	....
3rd quar.	38,696,000	....	42,381,000	....	....	....
October	13,350,000	....	14,285,000	....	4,612,000	....
November	12,603,000	....	10,251,000	....	6,991,000	....
December	9,997,000	....	6,408,000	....	10,900,370	....
4th quar.	35,950,000	....	30,944,000	....		
Preliminary total	137,377,000	....	135,887,000	....	....	....
Amt. of under est.	83,238	....	25,118	....	....	....
Final total	137,460,238	....	135,912,118	..	....	....

a Revised.

MONTHLY FLUCTUATIONS IN PRODUCTION, SHIPMENTS, AND STOCKS OF FINISHED PORTLAND CEMENT

The Bureau of Foreign and Domestic Commerce, of the Department of Commerce, reports that the imports of hydraulic cement in May, 1924, amounted to 161,304 bbls., valued at $232,950. The total imports in 1923 amounted to 1,678,636 bbls., valued at $2,964,098.

The imports in May were from Belguim, 115,592 bbls.; Norway, 33,808 bbls.; Denmark, 5,863 bbls.; England, 2,502 bbls.; Germany. 1,531 bbls.; Canada, 846 bbls.; France, 656 bbls.; China (Kwangtung), 506 bbls. The imports were received in the following districts: Los Angeles, 49,012 bbls.; Philadelphia, 30,562 bbls.; Hawaii, 26,135 bbls.; San Francisco, 12,821 bbls.; Porto Rico, 10,462 bbls.; New York, 7,423 bbls.; Florida, 7,327 bbls.; New Orleans, 7,041 bbls.; Maine, 4,921 bbls.; South Carolina, 3,003 bbls. and Washington, 2,597 bbls., which includes 840 bbls. from Canada.

The exports of hydraulic cement in May, 1924, were 88,850 bbls., valued at $262,290, of which was sent to Cuba, 29,600 bbls.; to the other West Indies, 5,338 bbls.; Mexico, 20,087 bbls.; South America, 18,498 bbls.; Central America, 7,313 bbls.; Canada, 3,169 bbls.; and to other countries, 4,845 bbls.

The statistics of imports and exports of hydraulic cement in June, 1924, are not available.

IMPORTS AND EXPORTS OF HYDRAULIC CEMENT, BY MONTHS, IN 1923 AND 1924, IN BARRELS (a)

Month	Imports		Exports	
	1923	1924	1923	1924
January	71,686	153,732	74,169	88,586
February	20,529	162,930	88,531	62,606
March	66,521	160,517	98,861	91,224
April	76,899	148,138	85,662	83,200
May	88,480	161,304	103,634	88,850
June	111,559	(b)	77,203	(b)
July	286,106	....	82,774	....
August	324,008	....	73,201	....
September	215,785	....	77,121	....
October	172,051	....	74,302	....
November	140,590	....	85,743	....
December	104,422	.	80,487	. . . .
	1,678,636	....	1,001,688	....

(a) Compiled from records of the Bureau of Foreign and Domestic Commerce.
(b) Imports and exports in June, 1924, not available.

Virginia Portland Cement Corporation

The Virginia Portland Cement Co., which has recently been incorporated in Virginia, is a subsidiary of the International Cement Corp. and in line with the International's policy of localizing its subsidiaries, the Norfolk property recently purchased from the Giant Portland Cement Co., has been sold to and will be improved and operated by the Virginia Portland Cement Corp. with offices at Norfolk.

While it is estimated that 8 or 10 months will be required to reconstruct and enlarge the plant, it is expected that the company will be in a position to place its product on the market in the spring of 1925 under the trade name Southern Star portland cement. The plant is located on property between the Belt Line R. R. and the Elizabeth river, opposite the extension of Ohio street and South Norfolk.

The marl deposits along the tributaries of the James river above Norfolk have been carefully checked in the various laboratories of the International corporation and it has been found that they can be treated very satisfactorily by the same process the company uses at the Houston, Texas, plant. With the knowledge and experience gained there, no difficulty should be experienced in manufacturing the highest quality of portland cement at the Norfolk plant when the mill has been converted into a modern one.

The company's engineers are working on specifications and drawings for the new plant which it is estimated will cost approximately $1,500,000. The actual construction work, except the erection of the laboratory and mill office building will not be commenced before all of the plans are completed, sometime within the early fall. The new plant will have a capacity to supply 4,000,000 sacks of Southern Star portland cement per year to the Norfolk and contiguous territory and it is planned to make the plant the last word in cement construction.

Portland Cement

By Thaddeus Merriman
M. Am. Soc. C. E., Chief Engineer Board of Water Supply, City of New York, U. S. A.

A paper prepared for presentation at the International Cement Congress, London, April 22 and 23, 1924.

Although portland cement was first produced in England in 1824, the product of that date can hardly be considered as belonging to even the same class of material which today bears the name. The present era of portland cement came into being with the development of the rotary kiln, and its beginning may be considered as contemporaneous with the opening of the twentieth century. The product of today is materially superior to that of 20 years ago, largely because it is manufactured under more definite supervision. The mechanical processes involved in its making have been highly developed, and the regulation of the raw material at all stages, from the quarry to the finished cement, has, with the single exception of the control of the kiln temperatures, been brought to a high state of perfection. Notwithstanding these great improvements and developments, there has, however, been no substantial change in the inherent characteristics of the cement itself. The product of today is more uniform in quality, is ground more finely, and develops somewhat greater strength, but its essential properties have, with the passing of the years, remained unchanged. No new cements have been announced until quite recently, as in the case of those based on a high alumina content.

It is a surprising commentary that in such an important field of endeavor so relatively little positive advance in definite and specific knowledge should have been made. In every branch of science, whether pure or applied, it is possible to look back over the achievements of the past twenty years, and to note much of progress and of advance. With respect to the calcareous cementing materials, however, the pace has not been maintained. The reasons underlying this condition are twofold. First, cement has always been a material which has given substantial satisfaction to the user, who has taken such changes as have been made as a matter of course and has not demanded a better quality than the market afforded, and second, the nature and constitution of cement is so exceedingly complex that the field of study and research which it offers is not the most attractive.

As one of the results of the varied problems which confront our civilization, it has come about that portland cement concrete has assumed a most important role in all of our building constructions. On public and private work alike, concrete has come to be an indispensable material. And so it is but natural that there should have arisen, all over the world, a demand for a better knowledge respecting how best to make, use, and place concrete with a view to securing a maximum of permanence and durability. In the United States this work has been ably carried on in many of the public works laboratories, particularly those of the Federal Government in its Bureau of Public Roads. The Portland Cement Association, an organization maintained by the principal manufacturers of portland cement, has taken a leading part, and has done work of the greatest value. A number of college laboratories have contributed largely to the science of concrete, and among them it seems proper to refer to the researches conducted under the auspices of the University of Illinois. A joint committee of the principal engineering societies of the United States has had this subject under advisement for several years, and is well on its way toward standardizing the procedures of making and the qualities of the aggregates which go to compose the concrete.

These researches, however, have not touched on the problem presented by the cement itself. It seems to have been tacitly assumed that all portland cement meeting the requirements of the standard specifications is of equal quality, and the principal, if not the only, improvement in concrete is to be secured through careful selection of its aggregates and by attention to the technique of its making. The cause of concrete, however, is inextricably bound up with the cause of cement. The better the cement, the better will be the concrete made from it. The best and most durable concrete can be made only from the best of cement, and then only if the technique followed in the making is correct.

The demand for a better, a more durable, and a more permanent concrete cannot, it is believed, be entirely satisfied until a better cement is produced. This, of itself, must not be construed as a condemnation of portland cement as now made. The cement of the period is a splendid material, and in many situations produces a concrete which is well-nigh perfect. Under other conditions of exposure, however, it is not so satisfactory, and sooner or later disintegration begins. It is inevitable that a better cement will appear and displace that which now dominates the markets of the world. The natural cement of 1890 gave way to the portland cement of today. In like manner will portland yield its high position to some yet unknown successor. The natural laws of progress and development are not to be denied.

Among the early investigators who focused their attention on cement was Vicat, whose clear and logical deductions have been the basis of a large part of all subsequent research. In the United States, the outstanding work on portland cement and its constituents has been that done by Shepherd, Rankin, and Wright of the Geophysical Laboratory of the Carnegie Institution, and by Bates, Klein, and Phillips of the United States Bureau of Standards. These noteworthy investigations have resulted in a satisfactory understanding of the reactions which occur during the process of cement manufacture, and in establishing the identity of the several constituents which go to make up the output of the kilns. The work of these investigators has had a marked influence on manufacturing processes generally, and has come to be recognized as the essential expression of the last word respecting the composition and characteristics of the several compounds which are to be found in all well-made portland cement.

As the result of these epoch-making investigations and collateral studies respecting the several constituents, we are put into the fortunate position of being able to visualize some, at least, of the processes which occur when portland cement is tempered with water. The following theory is advanced at this time for the purpose of stimulating discussion. It is hoped also that the suggestions therein contained will be helpful as a guide to further investigations. Even if the consequences of this hypothesis are not in all respects substantiated, the way to a new field of research will be indicated.

When water is added to portland cement, a number of complex and interrelated reactions occur. It is not safe to make generalized deductions as to the combinations which take place on the sole basis of the behavior of the individual constituents when hydrated alone or in combination with a material excess of water. The problem to be attempted is a visualization of the conditions existing within a volume of cement which has been tempered with a quantity of water sufficient to make the mass only slightly more than damp.

All of the available evidence indicates that the first reaction which occurs is a hydration of the tricalcium aluminate ($3CaOAl_2O_3$). The products of this reaction in the presence of the relatively small quantity of water are unknown, but the net result is the production of a degree of alkalinity somewhat in excess of that which would be caused by a simple solution of $Ca(OH)_2$, or by the hydration of CaO. In the alkaline solution thus formed, the tricalcium silicate hydrates with great rapidity, and the consequence would be a flash set, if it were not for the restraining influence of the calcium sulfate, which, as the result of long experience, is added to all portland cement. The acidity of calcium sulfate neutralizes the alkalinity produced by the hydration of the aluminate and holds the OH concentration below that at which the silicate will readily hydrate. The overall result then, at this stage in the process, is the establishment of a condition of essential equilibrium in an alkaline solution, and the "set" is thus retarded. As time goes on, however, and water is withdrawn by the hydration of more of the aluminate, the solution steadily becomes more alkaline until a critical concentration is reached. At this point, with almost startling suddenness, the preliminary set occurs, and the temperature of the mass, if the escape of heat is prevented, rises far above that of the surrounding atmosphere. This point is usually reached within three or four hours after the cement has been tempered, if the quantity of water used is that generally employed to produce the so-called "normal consistency." The evolution of heat now continues until the condition of final set is attained, when the rate at which heat is generated suddenly reduces and generally ceases entirely within a further period of from two to four hours. In this interval, during which the only external manifestation of change is the generation of heat, the hydration of the tricalcium silicate occurs. The heat developed is simply that resulting from the hydration of one molecule of CaO which is split off from the $3CaOSiO_2$.

In the average well-burned cement, about 30% by weight consists of $3CaOSiO_2$, so that the CaO resulting represents somewhat more than 7% of the total. Now, in the solution already burdened with an alkalinity due to the hydration of the aluminate, the CaO can be absorbed no faster than $Ca(OH)_2$ passes out in either the crystalline or the amorphous form. The early strength (at 24 hours) of the cement is due to the calcium hydrate thus formed, as well as to the amorphous calcium silicate resulting from the hydration of a part of the dicalcium silicate ($2CaOSiO_2$) which is left after CaO has been split off from the tricalcium silicate. This dicalcium silicate may be thought of as being in a nascent state and hence ready to hydrate promptly. Its properties undoubtedly differ markedly from those of the dicalcium silicate which is present as a separate and distinct compound, and in which no change in molecular equilibrium has occurred.

The subsequent actions in the process of setting are comparatively simple. They consist almost entirely of the further hydration of the dicalcium silicate, although various minor processes, begun during the earlier stages, develop and continue, as, for instance, the reactions between the SO_4, and the alumina, and as between the $Ca(OH)_2$ and the carbon dioxide of the atmosphere. As more and more of the dicalcium silicate changes into the amorphous form by the taking on of water, the strength of the specimen continues to increase until a point is reached at which the strength falls off or else ceases to rise. It is at this stage that the increasing volume of the amorphous silicate begins to overcome the strength imparted to the mass during all of the previous setting process. This point marks the crucial period in the life history of the mass. If the internal stresses so produced are resisted, it will come through with flying colors. On the other hand, if this test is not passed, cracking due to the internal expansion will occur, and the subsequent processes of disintegration will be accelerated by frost and other atmospheric agencies.

The limitations of space preclude a further elaboration of the hypothesis presented, and it must suffice to say that the argument is predicated almost entirely on observed and reported facts. It explains many of the points which have given rise to much discussion, and, while not in all respects satisfactory, its evident deficiencies may themselves contribute a due share to a better and a more complete knowledge of this important subject.

It is the purpose of this paper to stimulate discussion, research, and tudy of the many problems which are pressing for solution in the realm of concrete and cement. A few of the more promising lines of thought which may lead to a better ultimate understanding are here presented.

1. When water is added to cement, there is, at first, a slight elevation in temperature, followed later by a marked and substantial temperature rise. To what particular reactions are these manifestations due, and how, if at all, may they be controlled?
2. The greater the quantity of water added to cement, the slower the resulting "set" and the less the strength. How may it be possible to change conditions so that an increase in water will not cause a decrease in strength?
3. What criterion can be devised to serve as an index of the permanence and durability of a particular cement?
4. What, if any, effect does the practice of "quenching cement clinker have on the quality and permanence of the resulting cement?
5. What, if any, effect does the steam curing of cement in the ball mill have upon the quality of the resulting product?
6. Does it seem as though a practicable method can be devised for the purpose of bringing about an earlier hydration of the dicalcium silicate which is the predominating compound in nearly all well-burned portland cement?
7. The strength of a cement is, in some measure, inversely proportional to the distances separating its particles. How can these particles be caused to lie more closely together? That is to say, how can a denser mortar or concrete be made?
8. The strength of a mortar or of a concrete is, in great measure, dependent on the ability of the hydration products to adhere to the surfaces of the sand and stone. What steps can be taken to increase this property?
9. Of the usual ingredients of a normal portland cement the tricalcium silicate seems to be the most valuable. How, if at all, can the output of this constituent be economically increased?
10. At the present time, none of the standard specifications includes a test for sufficiency or completeness of burning. Would such a test be of value? If so, what possibilities suggest themselves?
11. Little, if any, attention has been given to the solubility of cement in solutions of varying characteristics. Is it not possible that much may be learned by a comprehensive investigation of the behavior of cement in solutions of such substances as glycerine, sugar, or sodium carbonate?

12. All portland cements which meet the requirements of the standard specifications are not of equal quality. This is a fact recognized by the artisan and the engineer alike. How can these differences be made manifest by suitable tests?

Neither our knowledge of the characteristics of cement nor the technique of its employ has been developed much beyond a preliminary state. There are many latent possibilities, among which those suggested in the preceding text may prove to be of interest and value. The thing of vital importance in this inquiry is a broadening of true scientific knowledge in the great field of the calcareous cements, which, literally speaking, are at the very foundation of all engineering constructions. It is sincerely hoped that the engineers of the British Empire will join with their brethren of the United States in a concerted effort to advance and further the general knowledge of this important question.

The author is under great obligation to the authorities of the International Congress for the opportunity of presenting this paper. He is indebted also to Mr. Carl E. Grunsky, president of the American Society of Civil Engineers, through whom was conveyed the courteous invitation of Mr. Maurice Kiddy, secretary of the Institution of Structural Engineers.

Missouri Anti-Trust Case Ends

The state of Missouri's so-called anti-trust suit against the St. Louis Material Dealers' Association has been settled by a stipulation agreed on in the state Supreme Court at Jefferson City whereby the Missouri Portland Cement Co. paid a fine of $27,500 and accepted a decree of ouster from the state, the decree to be suspended during good behavior, and a fine of $10,000 has been paid by counsel for the former Continental Portland Cement Co., which is now controlled by the Alpha Portland Cement Co. Twelve smaller concerns, members of the Material Dealers' Association were not fined as it was stipulated by the Missouri Portland Cement Co. in the settlement that all cases against them were to be dismissed.

Quo warranto proceedings were filed against the material dealers by the Attorney General of the state in July, 1921. He charged the formation of pools, with efforts to regulate and fix prices to the detriment of the public. Restraint of lawful trade and prevention of free competition were also alleged.

Several conferences were held on settlement of the case, a tentative agreement having been reached last December for the two big cement companies to pay a fine of $20,000 and $10,000, but this plan failed before a stipulation could be filed in the Supreme Court. The Glencoe Lime & Cement Co., Hunkin-Willis Lime & Cement Co., and St. Louis Material and Supply Co. were to be excluded from the settlement and cases against all the rest of the members of the Material Dealers' Association were to be dismissed.

The Missouri Portland Cement Co., and Continental Portland Cement Co., were members of the Mid-West Cement Credit and Statistical Bureau of Chicago, against which a Federal suit is pending. The practices of the Mid-west Bureau are alleged to be in violation of the state anti-trust laws.

It is apparent that the settlement as recorded in the case should be satisfactory to all parties. H. L. Block, president of the Missouri Portland Cement Co., issued the following statement regarding the settlement of the case:

> This company was a member of the Midwest Cement Credit and Statistical Bureau of Chicago, and also of other organizations, the purpose of which was to furnish statistical information relating to the cement industry.
>
> Recent decisions of the Federal and State courts have indicated a tendency on the part of the courts to hold such statistical associations to be a violation of the anti-trust laws. Therefore, while not pleading guilt to the suit brought in this state by Attorney General Barrett, alleging that this company had violated the state anti-trust laws, we have thought it best to settle this litigation.
>
> The statistical associations to which this company belonged were organized and functioned under the advice of eminent counsel, and we hope and believe that the practices of these associations will be upheld by the Supreme Court of the United States in the test case against Eastern cement manufacturers, which is now pending. Very shortly after the beginning of the cement anti-trust litigation in 1921, the members of the various bureaus ceased to furnish or receive the statistical information theretofore furnished or received, thus showing their willingness to discontinue practices which have been questioned.
>
> This company feels that it has not violated the laws in intent. There has been a good deal of talk about a cement trust. None has existed, in fact.
>
> While cement prices are fairly uniform in any given territory, this has been brought about by the standardization of cement, due to the requirement that it must register up to the United States Government standards, by operating costs being practically the same, and by competitive conditions which have forced all manufacturers to meet the price made in any given territory by the company willing to sell at the lowest prices.
>
> Also, while the practices of the various cement companies have been much alike, this has been brought about by the evolution of the business itself, and not by agreement. The same practical uniformity of prices and methods prevail, in our opinion, in almost, if not all industries, and for the same reasons companies meet competitive conditions, and for business reasons, though not as the result of agreements, adopted practices best suited to the particular industry.

Suit Filed in Missouri Against Atlas

Attorney General Barrett filed suit in the Missouri Supreme Court, on July 15, against the Atlas Portland Cement Co., asking that the corporation be fined and ousted from the State for violation of the State's anti-trust law.

The action is based on the corporation's membership in the Midwest Credit and Statistical Bureau of Chicago, a combination of cement companies, formed, it is alleged, to exchange information about prices and production. Operation of the bureau, the Attorney General contends, is in violation of the Missouri law.

The Atlas company is a Pennsylvania corporation and has a plant at Hannibal, Mo. The suit was filed in spite of the fact that the Atlas company had announced that it withdrew from the Chicago bureau in 1922.

Arthur Berg Nielsen

Arthur Berg Nielsen, general superintendent of the Great Western Portland Cement Co. laid down his life June 28, 1924, at the age of 32 years, in a heroic attempt to save his assistant from drowning. Nielsen had been superintendent of the Mildred plant for about three years, prior to which he was with F. L. Smidth & Co. engineers, of New York, in the design and construction of the Mildred plant. The successful operation of this plant is due to Nielsen's brilliant work.

Before coming to the Great Western Portland Cement Co., Nielsen was in charge of important engineering work for F. L. Smidth on other cement plants throughout the United States.

Nielsen was born in Bergen, Norway, and received his degree in civil and mechanical engineering in technical schools of that country. He came to the United States in 1911 and since then devoted his entire time to the cement industry.

Potash in 1923

In 1923 the United States produced 39,029 short tons of crude potash salts, containing 20,215 short tons of K_2O, according to information furnished by the Department of the Interior through the Geological Survey. Of this output 32,254 short tons of crude potash, containing 17,982 short tons of K_2O, was produced from mineral sources—natural brines and dust from cement mills and blast furnaces—and 6,775 short tons of crude potash, containing 2,233 short tons of K_2O, was produced from organic sources—molasses distillery waste and beet sugar refinery water. This output was made by 8 companies operating 12 plants in California, Indiana, Maryland, Nevada, and Pennsylvania.

Sales and stocks on hand were reported by several companies that produced no potash in 1923. The quantity sold, as reported by 8 companies, operating 11 plants, amounted to 35,164 short tons of crude potash, containing 19,281 short tons of K_2O, and was valued at $784,671. The stocks on hand December 31, 1923, as reported by 10 companies, operating 14 plants, amounted to 34,794 short tons of crude potash, containing 12,363 short tons of K_2O.

Imports of crude potash into the United States in 1923 amounted to 748,101 short tons, containing 209,581 short tons of K_2O, valued at $15,354,755. Of this amount 712,441 short tons of crude potash, containing 194,079 short tons of K_2O, valued at $10,624,475, were salts used mainly in the fertilizer industry.

Complete electrical equipment of a new cement mill at Coreen, Ga., is planned by the Clinchfield Portland Cement Corp., of Kingsport, Tenn. A contract was recently closed by this concern with the General Electric Co., for two 1000-kilowatt turbine generators, a 16-panel switchboard, over 60 induction motors of various sizes and six super-synchronous motors, four rated 500 h.p. and two, 300 h.p.

In the plant layout, the induction motors specified are of such capacity that they will operate fully loaded and, by including a large amount of synchronous apparatus, it is expected that the entire plant will operate at or very near unity power-factor at all times.

Gypsum Mined and Shipped in 1923

The Department of the Interior issues the following preliminary statement, compiled by the Geological Survey, which gives the essential details of the gypsum industry in 1923. The total quantity of gypsum mined in 1923 was 4,753,448 short tons and exceeded that of 1922 by 973,499 tons or 26%. The total value of sales of both crude and calcined gypsum was $34,888,155, an increase of $5,527,004, or 19%.

Men and Mills

Notes from the Field

An unusually elaborate dinner in connection with sales promotion plans was given recently at Hotel Pennsylvania, New York, by the Lehigh Portland Cement Co. Fifty men were greeted by J. C. Wahlen, special representative of the Lehigh company and by B. L. Swett, sales manager.

The Muscle Shoals Portland Cement Co. with a capital stock of $100,000 all paid in, has been incorporated according to reports from Alabama. The company will build a cement mill at Sheffield, Ala. Cement stone is to be found in almost inexhaustible quantities near Muscle Shoals, experts report.

A Memphis firm, the Fischer Lime and Cement Co., is declared to be one of three principal stockholders in the big new Hermitage Portland Cement plant at Nashville, which alone can consume its entire output of 600,000 bbls. per year according to a statement issued by the cement plant which started operations in February of this year.

The Hermitage Portland Cement Co. plant is one of the most modern in the United States. The site of 135 acres contains a limestone quarry and a clay deposit sufficient to run the plant at the rate of 600,000 bbls. per year for 70 years.

Reuben Miller, Egypt, has resigned his position as chemist in the laboratory of the Giant Portland Cement Co. The vacancy is being filled by Ralph Kohler, chemist, Egypt.

Arthur Walton Smith, an electrician at the Alpha Portland Cement Co.'s plant, Easton, Pa., died recently of pleuro-pneumonia.

William B. Shaffer, former resident in Allentown, died recently, at his home in Nazareth. Mr. Shaffer was interested in cement manufacture, having been a promoter of the old Nazareth Portland Cement Co. in 1895, later developing the Nazareth Dexter Cement Co. and the Phoenix Cement Co. He subsequently moved to Martin's Creek and became interested in the Superior Portland Cement Co. and when this was sold to the Alpha Portland Cement Co., he went to Alabama to develop a tract known as the Coosa Portland Cement Co.

GYPSUM PRODUCED AND SOLD IN THE UNITED STATES, 1923, BY STATES

	Number of Active Plants Reporting	Total Quantity Mined (Short Tons)	Sold without Calcining				Sold Calcined		Total Value
			Agricultural Gypsum		For Portland Cement, Paint, and Other Purposes		Short Tons	Value	
			Short Tons	Value	Short Tons	Value			
California	3	111,832	2,865	$21,796	(a)	(a)	24,936	$374,040	$670,495
Iowa	7	685,041	329	1,961	134,566	$383,322	431,829	4,983,249	5,368,532
Kansas	3	135,019	(a)	(a)	54,021	141,961	71,349	700,490	842,740
Michigan	6	586,987	616	3,465	135,000	351,602	341,746	2,897,926	3,252,993
Nevada	4	298,390	(a)	(a)	(a)	(a)	226,753	1,891,639	1,952,007
New York	8	1,361,116	1,249	5,906	228,831	712,093	823,241	9,626,746	10,344,745
Ohio	3	526,861	(a)	(a)	17,563	55,014	432,511	4,919,375	4,981,542
Oklahoma	4	290,121	......	......	47,041	125,182	202,323	2,123,713	2,248,895
Texas	4	344,104	......	......	......	......	254,512	2,177,983	2,237,024
Utah	3	44,531	(a)	(a)	(a)	(a)	33,520	269,148	286,957
Wyoming	4	......	......	......	......	......	27,945	176,791	176,791
Other States (b)	16	335,802	(c)20,367	(c)116,898	(c)204,794	(c) 658,236	230,713	2,169,619	2,525,434
Total	65	4,753,448	25,426	150,026	821,816	2,427,410	3,101,378	32,310,719	34,888,155

(a) Included under "Other States."
(b) Alaska, Colorado, Montana, Oregon, South Dakota, Virginia and New Mexico.
(c) This figure includes also output of States entered as (a) above.

The Turner Construction Co., New York, which has the contract for repairing and overhauling the Pennsylvania cement plant, has a day and night shift at work at present dredging the large reservoir.

One of the most active industries in the vicinity of Birmingham, Ala., is cement manufacture. The past three months have seen heavy production and very steady shipment of the product. The prospects for July and August are exceptionally bright. No cement is being stored and it may be necessary to take some from the storehouses, according to reports from that district. The output is being increased by the addition of a fourth kiln by the Lehigh Portland Cement Co. at its Tarrant City plant, near Birmingham.

Cement mills of the Lehigh district gave notice to the Interstate Commerce Commission and to the carriers that if the commission even tentatively, finds rates on cement from the Atlas Portland Cement Co.'s Hudson mill excessive they will file complaints attacking the entire cement rate structure of New England.

The Lehigh district cement mills are interveners in the Atlas case. Their general position is that they do not regard the rates as excessive, but that if the rates from a single mill in the Hudson district are reduced it will be incumbent upon them to open up the whole structure so as to forestall destruction of the existing balance of differentials. To grant the petition of the Atlas company for a rate reduction would be to destroy the nicely adjusted Hudson group, which these mills assert is not on a reasonable basis.—*Financial American.*

Cement shipments out of the Lehigh Valley have increased considerably during the recent past, according to reports from that district.

About twenty members of the Allentown Chapter, American Association of Engineers, recently inspected the crushing plant of the Giant Portland Cement Co., at Egypt, and the waste heat boilers at the Bath Cement Co.'s plant at Bath.

A party of engineers, public officials and others of South American countries, including Chile, Argentine and Brazil, are touring the United States in the interest of inaugurating good road programs. The tourists are in charge of Thomas H. McDonald, chief, Bureau of Public Roads, United States Department of Agriculture, and are especially interested in portland cement, its various uses and the process of its manufacture.

The Arkansas Valley Portland Cement Co. has purchased 4,500 acres of land at Stone City and plans to establish a cement plant at Carlisle Springs, Colo., according to a report from that state.

The $500,000 additional preferred stock in the Signal Mountain Portland Cement Co. has been subscribed, according to announcement following the quarterly meeting of directors by President John L. Senior. Directors and their associates have subscribed for the entire issue, the official stated.

The preferred stock will be used to retire the convertible construction notes in this amount. The construction notes are to be retired on November 1, next. Announcement that the stock had been subscribed was probably the most important development at the meeting.

Members of the board present at the quarterly directors' meeting, held in the offices of the company were: W. A. Sadd, chairman; J. L. Caldwell, vice president; C. S. Steward, vice president; J. P. Hoskins, secretary-treasurer, and C. W. Howard, all of Chattanooga; J. L. Senior, president, of Chicago; F. A. Stephenson, Mason City, Ia., and R. G. Wright of Knoxville.

The erection of the third unit of the plant was not considered at the directors' meeting. It is possible that work on this unit will be started in the fall.

The Jaite Co., Jaite, Ohio, near Akron, is one of the largest manufacturers in the country of heavy paper bags. This company has grown considerably since it was organized about 25 years ago. The popularity of the Jaite Puncture and Waterproof Bags with cement and flour manufacturers has made necessary several additional plant units in the past few years. The Austin Co., engineers and builders, Cleveland, has been awarded another contract by The Jaite Co. The new unit is to be an Austin No. 2 Standard Building, 90 x 130 ft. Construction and material purchases will be made through the Cleveland office of the builders.

At the recent annual meeting of the Acme Cement Corp., held in Catskill, N. Y., directors were elected as follows: William H. Baker of Montclair, N. J.; Charles G. Watt of Lancaster, Pa.; Luther G. McConnell, Saugerties; Donald B. Watt, formerly of Catskill, and Ralph W. Gwinn of New York.

At a meeting of the directors the following officers were elected: W. H. Baker, president and general manager; Charles G. Watt, vice president; Luther G. McConnell, secretary and treasurer. Herbert H. Kessler, an engineer, is employed by the Acme Cement Co.

The Lehigh Portland Cement Co.'s wooden diversion dam on Sullivan Creek, about five miles above Metaline Falls, Wash., will be replaced with a concrete structure at a cost of about $35,000, according to an announcement attributed to W. G. Perrow, district manager of the company.

The Mataline Falls, Wash., plant of the Lehigh company which has been closed during the summer will probably reopen about September 1.

The cement zone south of Catskill, N. Y. was recently visited by men who had secured options on property on Straake Ridge, from the former Charles A. Post farm south to a point between the Acme and Alsen plants, and on other lands extending to the Hudson river. It is reported that the interested parties represent the Lehigh Valley Portland Cement Co., one of the largest in the industry.

The July docket of the Alabama public service commission shows cases of the Gulf States Portland Cement Co. and Lehigh Portland Cement Co., against the Alabama Great Southern Railroad and others; complaint against rates on cement, carloads from Spocari to points in Alabama and petition for reparation.

Announcement was made by the Interstate Commerce Commission recently that hearings would be held July 26 by Examiner R. V. Pitt in Washington on those portions of applications filed by 126 railroad carriers proposing to continue rates for the transportation of cement, carloads, between points in southern territory on the one hand and points in official classification on the other.

The twenty-fifth annual meeting of the stockholders of the Dexter Portland Cement Co. was held July 8 at the company's office at Nazareth, when the following directors were elected for the ensuing year: John A. Miller, Joseph Brobston and Peter S. Trumbower, Nazareth; Mark T. Swartz and Dr. William F. Cope, Easton; Frank A. Pfaelzer and George E. Bartol of Philadelphia. The directors will organize later. Reports showed that the company had a prosperous year.

The Pennsylvania Pump & Compressor Co. of Easton, Pa., announces that the Kilner-Mills Co., General Motors Bldg., Detroit, Mich., is its representative for the state of Michigan and Northwestern section of Ohio.

The products of the Pennsylvania Pump & Compressor Co. offered by the Kilner-Mills Co. are the well-known Pennsylvania air compressors, in both single and double stage types and include direct connected gasoline driven portable compressors. The pumps handled are the centrifugal double suction single stage, multi-stage and a portable known as the Penway pumper.

A small tonnage of Special brand cement, the new quick hardening cement which is being introduced in England has been supplied to the British Admiralty and it is planned to test the cement on a large scale under practical working conditions at one of the Admiralty's dockyards. This use of the cement is in addition to its numerous applications, reported by Bruce, Dawson & Co., 70 Finsbury Pavement, London, England, sole concessionaries for Great Britain, Ireland and Dominions, by numerous public bodies, surveyors and railroad companies.

George E. Nicholson of Kansas City, Mo., has resigned as president and director of the Yosemite Portland Cement Co. of Merced, Calif., having disposed of his interests in that company.

The Vulcan Iron Works of Wilkes-Barre, Pa., has secured control of the Meade patents for vertical lime kilns and the Zepp patents for an automatic continouus batch hydrator, and these machines hereafter will be exclusively manufactured by them. Both of these machines are the products of Richard K. Meade & Co., of Baltimore, Md., whose vast experience in lime burning and kindred limes makes their design of machinery valuable. The Vulcan Iron Works is now prepared to quote on and build complete lime burning and hydrating plants, using either the Meade vertical kiln or the Vulcan rotary kiln for lime burning.

Link-Belt Puts Out New Grease Cup

A grease cup is a small matter in a plant or factory, but it can be a nuisance and a cause of expense far out of proportion to the cost of the cup. Recognizing this, the Link-Belt Co. of Indianapolis has developed a new top for its regular compression grease cup. This top is hexagonal in shape, which provides not only a good grip for the hand but one for a wrench. Cold, stiff grease makes a compression cup very hard to turn, and a pipe wrench is not always accessible. The hexagonal shape provides grip spaces for the ordinary wrench.

Also, this cup is provided with a raised slot so that the cup can be turned with a screw driver, when it is so located that it is inconvenient for the hand or wrench.

Ruggedly made of malleable iron, the new cup, known as the Hex-top grease cup, is absolutely grease tight, according to the manufacturers.

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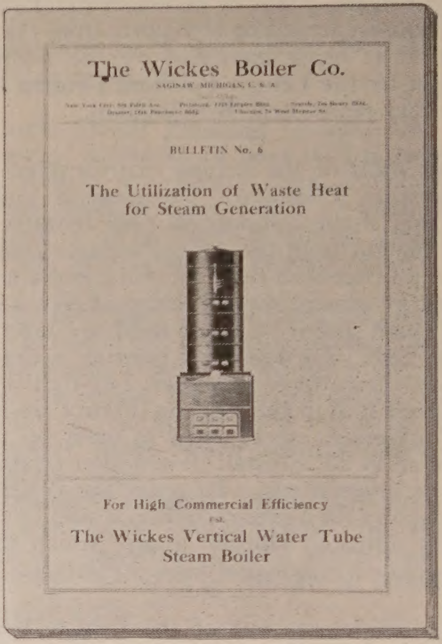

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